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AND

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PIG-IRON SPECIFICATIONS.

IT is very probable that one of the effects of the formation of the British Foundrymen's Association will be that the question of the purchase of pig-iron by analysis instead of by fracture will be brought to the front. Very little has as yet been done in this direction, although many foundries have experienced great difficulty in securing an iron that met all their requirements. More especially is this the case in, say, the electrical industry, where, in addition to the ordinary requirements, special factors, such as magnetic permeability, have to be taken into consideration. The great advances in the scientific management of foundries which have already taken place and which are likely to become still more apparent—as a result of the formation of the British Foundrymen's Association and the publication of the FOUNDRY TRADE JOURNAL, and its contemporaries in Germany and elsewhere—leads us to suppose that it cannot be long before the method of sale by fracture becomes obsolete in this country. In making this statement no doubt we shall meet contradiction from a number of our readers, and it is undoubtedly a fact that the old system has

not proved a failure as regards the quality of the castings that are made. Suppose, however, that an iron is deficient in silicon. The foundry has to add expensive ferro silicon at a cost of say, £16 or £17 a ton, and the bringing up of the percentage of silicon to the required limit may easily mean an extra cost of product of 3*s*. a ton. Now if the silicon were specified it would be possible to either get iron of the required percentage or to penalise those irons falling under the prescribed limit.

Manufacturers of pig-iron will unquestionably in the future have to pay more and more attention to the chemical constituents of the iron they sell in order to maintain a reputation for uniform qualities of foundry iron. On their part it means the substitution of the skilled chemist for the rule-of-thumb grading of the pig bed. On the part of the foundry it means the employment of a chemist.

Of course, a number of foundries already employ such an official, and the very small foundries could not afford the cost of a chemist. But there are a large number of foundries which, in the aggregate, turn out three-quarters or more of the total output of castings where chemical control of the mixtures would conduce to economy. This has been the case in the United States and Germany, and presumably it will be the case here also.

We have been able to secure for publication the specifications which the British Thomson Houston Company, of Rugby, have drawn up to meet their requirements, and they will be found in another part of this issue. No doubt many may criticise them, and it is in any case difficult to evolve an ideal specification which requires no amendment. But it is at any rate a start, and we commend them to our readers, from whom we shall be glad to receive expressions of opinion on the subject.

BRITISH FOUNDRYMEN'S ASSOCIATION.

IN last month's issue we were able to give a brief account of the proceedings at the first convention of the British Foundrymen's Association at Manchester. We are now able to give the report of the secretary, Mr. F. W. Finch, which gives in detail the steps that led up to the formation of the association. Mr. Finch's report is as follows:—

THE SECRETARY'S REPORT.

"It will no doubt be remembered by a few of those present who read the FOUNDRY TRADE JOURNAL that a correspondence was carried on in that journal for several months *re* an English foundrymen's 'association,' somewhat on the lines of the American Foundrymen's Convention.

"A very able article was written on the subject by Mr. Percy Longmuir, who, I am pleased to say, is with us today, and several others wrote on the same subject. Feeling that we might keep on writing for another twelve months if someone did not take the initiative, on the advice of Mr. John G. Stewart, of Urmston, I wrote to the editor of the journal, asking him for the names and addresses of those who had written on the subject, so that I could write them. The editor supplied me with the names, and I at once wrote them all, asking if they would form themselves into a committee to put the convention into shipshape. They all replied to my letters, but several could not, on account of circumstances, join.

"Having got the names of several persons—our president being one of them — I called them together on Saturday afternoon, April 9th, at the Cobden Hotel, Birmingham. Those who answered the appeal and attended the meeting were: Messrs. R. Buchanan, C. Morehead, J. Ellis Woolston, F. J. Cook,

F. W. Shaw, and W. Vickers—not a very large number. but sufficient to set the association in motion. Mr. R. Buchanan was elected president, the rest of those present formed themselves into a committee, with power to add to their number. I had the honour of being elected hon. secretary and treasurer. A circular was drawn up at that meeting which no doubt most foundrymen have seen, setting forth the advantages of such an association. When I got back to Gloucester, 3,000 such circulars were printed, and they were sent to those interested in the foundry business, taking the annual report of the Moulders' Society which gave the addresses of nearly all the foundries in England, Ireland, and Wales. Circulars were sent to all firms employing more than five moulders. After getting these away by post, I set to work to get the addresses of the Scotch firms.

"This proved rather more difficult, but having got the address of Mr. Jack, secretary of the Scotch Moulders' Society, I wrote him, asking if he would give me the addresses of the Scotch foundries. He very willingly replied and wished us every success in the establishment of the association. The best information I received was from one of our committee, Mr. W. Roxburgh, of Kilmarnock, who classified the addresses for me.

"Having got these circulars sent away, results followed which, in the opinion of the committee, and I hope of this convention, have been very satisfactory. This will be appreciated when I tell you that we have now enrolled ninety-four members, which include the whole of the United Kingdom—seventy-seven from England, nine from Scotland, six from Wales, and one from Ireland, and one from India. The finances are also very satisfactory, as the whole of the ninety-four members have sent their subscriptions, making the total of £35 5*s*. Our expenses have been £18 12*s*. 7*d*. We have in Gloucester branch of the Capital and Counties Bank, £12 2*s*. 6*d*.; and in the hand of your treasurer, £4 9*s*. 11*d*.; making a total balance of £16 12*s*. 5*d*. for future requirements.

Mr. Robert Buchanan, President of the British Foundrymen's Association.

"Sending out circulars and receiving remittances has not been all the work required, for the correspondence in connection with the association has been very heavy, many persons writing several letters before becoming members asking for more information than the circulars gave. I endeavoured to give the best information that was possible, and suppose it has been satisfactory as the

majority of them have become members of the association. Other correspondence has been in sending information to the different journals in the engineering trade. Many journals gave some information respecting our association, and I am pleased to say it has not been without result, having had several applications from readers of those journals. I also sent a letter and one of our circulars to the American paper, *The Foundry*, which gave us a very good report. One result of that was a letter from the secretary of the American Foundrymen's Association, which reads:—

"DEAR SIR,

"I learn with much pleasure of the formation of a British Foundrymen's Association, through our American technical press. Also the splendid compliment you give us in the announcement. Believe us that we are very grateful, not only for the courtesy involved, but for the knowledge that the hard work and effort we have given to the cause here in the face of disheartening apathy on the part of nine-tenths of the entire industry, who should jump at the chance to be benefited, is appreciated in other countries. We should like to cultivate close relations with your association, and I beg you to count on us in anything which our means allow to help along any lines of investigation of value to the founders of both Continents. I am sending you some literature we have gotten out recently, and will also send you as complete a set of our older publications as I can scare up. I also trust that you will put us on the mailing list, and hope for much and mutually profitable intercourse.

"Faithfully yours,

"RICHARD MOLDENKE.

"Dr. Moldenke has also sent me on a large parcel of literature.

"A committee meeting was held on June 9th, when it was decided to hold this Convention at Manchester on August 2nd, 1904, when Mr. John G. Stewart, of Urmston, who was present, kindly undertook the arrangements for the Manchester meeting, and he, in conjunction with the other gentlemen at Manchester, have done the work most satisfactorily, and deserve the thanks of this meeting for their assistance in bringing it to a successful issue. A sub-committee met on Tuesday evening, July 19th, at Birmingham, and drew up the programme. I have sent one with card of membership to every member of the association, and I hope every member has received his card.

"In conclusion, I do not think the circular sent to the different firms has reached those the committee mostly meant, but it is my intention shortly to get circulars delivered direct to foundry managers and foundry foremen, hoping to get better results with regard to membership. I take this opportunity in thanking our president for the great assistance he has gi[illegible]nally, and also the comm[illegible] kind assistance, and I sinc[illegible]t my efforts have given every member satisfaction."

PRESIDENTIAL ADDRESS.

We are able to give at length in this issue Mr. Buchanan's admirable presidential address, which will be found to deal not only with the subject of education, but also with the influence of foreign elements on pig-iron.

"It gives me great pleasure to see such a large and representative gathering of foundrymen met here to-day, and I desire to tender to you my thanks for the high honour conferred upon me by your election of me as the first President of the British Foundrymen's Association. No honour could be given me of a more pleasing character, coming as it does from fellow-workmen in the same field of labour. Our meeting here to-day, to my mind, marks the beginning of a new period in foundry matters so far as Great Britain is concerned. Our meeting as an association of foundrymen is interesting from the fact that it is a proclamation to our fellow foundrymen and to all the allied branches of engineering that we

mean to take our place in a line with, and to keep step with, the foremost ranks of engineering skill and applied science.

"It will be well to consider for a few moments what this association is and what it is not. Taking the latter first, this association has no politics, neither does it seek to have anything to do with the wage relationship betwixt employer and employed. We are a number of students, gathered to consider the problems which meet us every day in carrying on foundry operations on a commercial scale, and to learn from one another the varying experiences of each, and by so doing be able to apply to one's own work the experiences and knowledge of another, and thus reinforce the knowledge we ourselves possess. I am aware that many persons pride themselves on the exclusive information they possess, and it is so valuable they cannot afford to give any of it away. I think in most cases the knowledge of such people is valuable to them in the same way as the metal gold is valuable to the world. It is the scarcity which makes the value. The man who can tell all he knows about a subject is himself only a beginner in the study of the subject. It is thus on a principle of give and take we are now met, exchanging scientific and practical knowledge, and no one here is so poor as not to have some small gift to lay on the altar of knowledge.

"What kind of knowledge do we seek? We seek to know the laws that govern all the operations of a foundry, and by a knowledge of those laws produce work successfully; and successful work means economical work. This association, then, has to prove itself worthy of continued existence and continued support by the influence the members bring to bear upon the economical production of the best work in their respective spheres of labour.

"When I speak of the laws that govern foundry operations, I am not referring to anything which applies to foundries, and to foundries only. No powers are brought into play, and no phenomena are observed in foundry operations but are linked somewhere to facts of the outer world.

"The study of laws affecting metals and the phenomena which appear through the operation of those laws is, I trust, one of the main functions of this association. Why do we seek to study the oft-times hidden causes underlying all foundry operations? Simply that we may master them and harness them to the chariot of

Mr. F. W. Finch, Secretary and Treasurer of the British Foundrymen's Association.

progress. This study, when carried on in science schools and colleges, we term technical education. Of technical education as a name we have heard enough; of the thing itself we hope to hear a great deal more. Speaking recently of technical education a noted foreigner, a metallurgical engineer, now resident in this country, said: 'Do not speak to me of technical education in England. You simply cannot have it. Your elementary and ordinary day schools turn out youths so badly educated, or rather not educated at all, that no man or body of men *can* give technical education to them, even if they had the opportunity. There is no foundation to build upon.' That is a serious indictment of our system of education. That it is to some extent true all who have numbers of youths through their hands will agree.

"We have a right, I think in the interests of the industry we represent, to demand that such a state of things shall cease. What can be expected of schools if there are many administered by gentlemen such as the one I had a talk with not so long ago. This gentleman in the course of conversation informed me he was a school manager, and, later on, that he thought education was simply unsettling the working classes and making them discontented with their lot. If there are many such school managers, men administering education in homœopathic doses, not large enough to be dangerous to health and just enough to keep the patient quiet, then good-bye to any advance of the industries of this country by the way of technical education. Let us consider for a moment what the chances of rising above mere drudgery are for a youth of the kind which usually presents himself to our notice as desirous of learning foundry work. In most cases he is so badly equipped educationally as to be for years wholly unaware of the fact that he is ignorant of almost all things worth knowing. When he, as happens in some cases, becomes conscious of the existence of a higher knowledge, he is debarred by the inadequate education he has had from seeking to acquire such higher knowledge. Thus in deficient elementary education begins a life of practically unremitting toil, with no hope nor expectation of any rise above the dead level of 'the daily round, the common task.' Our educational system will be worthy of the name of system only when those who fear the unsettling effects of education are deposed from the positions they occupy, as drags upon the wheels of knowledge. It used to be said of the great Napoleon's army, that each soldier carried in his knapsack the bâton of a Field-Marshal. Why should not the common soldiers of industry carry equal possibilities oftener than they do now?

"My own experience of technical schools is such as to leave me with the highest possible opinion of the ability and devotion of the teachers, and of the value—actual monetary value—of the knowledge they impart. That they have a great influence on workshop practice there is no doubt whatever.

"That influence must continue to grow if we are to keep our place in the front rank of industrial nations. Many practical men have a contempt for those who have not actually worked at the trade and yet endeavour to elucidate and explain the laws and principles governing workshop practice. They have no faith in what they call 'book learning.' On the other hand, there are employers, few in number, I venture to hope, who do not put any faith in technical education, nor in those professing to possess it. Now, I think that both the workman who scorns book learning and the employer who holds technical education in light esteem are wrong. I admit now, as I have admitted elsewhere, that some of the foundrymen you and I have known, men who never heard of technical education, were, and are, unsurpassed as skilled

and successful workmen. I pay them homage for their excellence. You can call to mind, as I can, workmen and foremen of excellent powers as stated, and it is asked, nay, demanded, that we do as good work, produced at a lower cost, than they ever did. Now I think it is quite a legitimate demand that is so made. Many of us, if not all, have had improved tools provided us by which we may lower the cost of production. All of us in recent years have had freely given for our help the rich fruit of the mind of studious workers and thinkers, both in our own country and abroad. If we fail to assimilate and apply such a rich bounty of knowledge, then are we unworthy of our high privileges. I repeat that employers and capitalists have a right to expect better results from us than they had from our fathers. The future lies in the hollow of the hand of the practical man who to practical has added scientific training. There is a growing desire for such men, and I think the day is not far distant when the same call will be sent to our technical schools, colleges, and universities as has come to similar institutions in the Great Republic of the West. The call is from the great employers, and they say, 'Send us all your students who to practical have added scientific knowledge, and received your certificate. We will take them all and make foremen and managers of them.'

"I would commend to young men engaged in any way in foundry work careful consideration of present day conditions such as I have indicated, and to ask them to resolve to rise to the height of their opportunities.

"A branch of our knowledge of metals which has expanded greatly in recent years deals with the phenomema which are seen when heating, melting, or cooling metals. Not so many years ago, what took place in the course of heating, melting, and cooling was practically unknown. Heat is a mode of motion, and when metals were melted we considered that the heat caused the molecules of metal to vibrate so rapidly and with such large vibrations as to render the molecules so detached from each other as to be become what we call fluid. Some metals, such as zinc, pass almost directly into the gaseous form. On the other hand, wrought iron cannot be heated sufficiently to make it fluid unless it be in the electric furnace. These extremes I leave out of consideration, and refer to metals such as iron, steel, bronze, and so on which are non-volatile, and may be made fluid readily under ordinary workshop conditions. The belief that metals become fluid owing to cohesion of the molecules being partially and temporarily suspended by means of heat was and is perfectly correct. The melting of a metal was considered to take place as if all parts of the metal were at one and the same time in the same condition of partial fusion, say at the moment just before complete fusion. Text books state, for instance, that grey pig-iron passes from the solid to the fluid condition all at once or practically so, and that white pig-iron passes through an intermediate pasty condition before complete fusion takes place. We now have a more precise knowledge as to what is taking place as melting proceeds. Whatever the metal may be, unless it is absolutely pure there is present within it one or more compounds each of which has a lower melting point than the bulk of the metal. This compound of lowest melting point is called the 'eutectic,' and the term means the same thing no matter what the metal being considered is. The subject of eutectics has, however, been more considered in relation to the phenomena observed when bodies freeze or set. The eutectic is the first to melt when heat is applied, so is it the last to freeze or set when the substance is being cooled.

"Carbon dissolves in iron in much the same way as salt in water. The melting

point of pure iron is 1,600 degrees Centigrade, but the melting point gets lower as carbon is increased. When the compound of iron and carbon is cooling down, pure iron, or a solution of carbon in iron, containing, however, very much less carbon than the remainder of the metal, solidifies first. Should the remaining metal contain more than 4·27 per cent. carbon, then the excess carbon separates out as graphite. The metal which is the eutectic solidifies last at 1,150 degrees Centigrade and contains 4·27 per cent. carbon. Should the iron which is under consideration contain less than 4·27 per cent. carbon, we have a separating out and freezing of a portion of the iron in a pure condition. As the cooling proceeds there is a further separating and freezing of pure iron or probably iron and a little carbon in the combined form, and then a final freezing of the eutectic at 1,150 degrees Centigrade as before and with exactly the same percentage of carbon as before, viz., 4·27 per cent. Thus whether carbon be in excess of 4·27 per cent. or less than that amount the eutectic or mother liquor, the particular mixture of iron and carbon first to melt and last to freeze always contains 4·27 per cent. of carbon.

"It is almost invariably the case, as most of you are aware, that the purer a metal is the more difficult it is to melt. Every addition of substances other than the metal itself lowers the melting point. So we have other eutectics, silicon eutectic, phosphorus eutectic, and so on. High carbon steel melts at a lower temperature than low carbon steel; and if sulphur, phosphorus, or other elements be added, the melting point gets lower very rapidly. It eaches its lowest melting point in irons containing appreciable quantities of phosphorus. This is the reason hematite irons take more heat to melt them than phosphoretic irons do. The phosphorus eutectic is present in hematites to such small amount as to have a very small appreciable effect towards lowering the melting point of the whole. The heat has to go on increasing until the temperature is high enough to liquefy one of the other compounds existing in greater quantity than is the case with the phosphorus compound. Stead heated a piece of iron, but not nearly to melting point.

"So far as the eye could tell, it was still perfectly solid. He squeezed it in an hydraulic press, and a liquid was made to flow from the seemingly solid pig-iron. This was the phosphorus eutectic, and had phosphorus 6·84 per cent,, although the average for the iron as a whole was only 1·53 per cent. That is a very striking fact. Many metals have more than one eutectic.

"We have now got this idea clearly. In the first place, the elements which together form any commercial metal do not, in the case of any one of them, exist wholly in a condition of separateness from other elements. Manganese and sulphur form certain compounds, manganese and silicon form other compounds, and so on in a similar manner with the other elements.

"These compounds determine the character of the metal, and the strength or weakness, brittleness or tenacity, softness or hardness of a metal are simply reflexes of an internal structure built up principally by compounds of two or more elements, and not by elements existing as separate bodies contained within the metal.

"Professor Turner has been making some investigations recently regarding the size of the graphite flakes in cast iron, and obtained some interesting results. He took 250 grammes—*i.e.*, fully half an ounce of iron—dissolved away the iron by means of hydrochloric acid, and by various means isolated the graphitic carbon. The size of some of the flakes was surprisingly large. The iron was a No. 1 Northampton pig-iron, and

contained 3 per cent. of graphitic carbon. His results were as follows:—

	Per cent. of Total Graphite.
Graphite left on 30 sieve ...	27·6
„ „ 60 „ ...	45·6
„ „ 90 „ ...	9·3
Passed through 90 „ ...	17·6
	100·0

That which passed through the ninety sieve is called 'annealing carbon,' because it has the same characteristics as the carbon in malleable cast-iron. It is not distinguishable from a fine plumbago. Professor Turner also mentions that the graphite in cold blast iron is much smaller in size than the graphite of hot blast iron. This explains in very considerable measure the marked difference in strength betwixt cold and hot blast irons whose chemical constituents may be nearly similar in each case. Large graphite flakes form lines of weakness. Graphite finely divided and evenly distributed throughout the mass of iron, although the amount may not be less than in the case of large graphite, does not form the source of weakness large graphite does. When graphite separates out as iron in cooling, there is an arrest or retardation of cooling which is quite marked, in fact there are at least three such arrests of cooling and carbon separates at each arrest. This was first observed by Keep, and has been recently further investigated by Turner and Hudson with interesting results

"It is a pressing necessity at the present time that managers and foremen of foundries should be able to decide what an iron is suited for, and what may or may not be done with it if they have the analysis of the iron before them? Recently I noticed an advertisement for a cupolaman, and the terms the advertisement contained were quite refreshing. The cupolaman required was one able to mix metal for certain classes of castings which were subject to high temperatures, and concluded, 'No guess-worker need apply.' I was very pleased to see that advertisement, as it was direct evidence of a newer and more hopeful condition of things when employers are demanding precise and definite knowledge from their employees. Demand always brings supply; but at a price. There has been a lingering curiosity in my mind as to what salary a scientific cupolaman is worth.

"I fear that the knowledge required from the prospective cupolaman would be a bar to many would-be applicants, and I do not know if a great many managers and foremen could answer off-hand, if asked, what kind of iron they would mix to give a metal which would successfully withstand high temperatures. Our short study of eutectics may have thrown some light on an interesting branch of metallurgy, but anyone who aspires to mastery of the subject must acquire a fair degree of knowledge of the influence of the various constituents present in cast-iron, and the part these constituents play in determining the character of the iron.

"*Carbon.*

"The amount of carbon present in cast-iron, as well as the condition as graphite or combined carbon in which it exists in the iron, is almost wholly controlled by the other constituents present. When silicon is in excess, say 4½ to 5 per cent., then the total carbon is usually under 3 per cent., and what carbon there is, is almost wholly in the graphitic form. When the total carbon is low in amount, the iron, though soft, tends to 'sink' or draw in local heavy parts. When graphitic carbon is formed as the metal cools, it evidently occupies a greater space as a flake of graphite than it did as a constituent of the compounds carbon forms when existing as combined carbon. Thus, if the total carbon is

low, the graphite flakes are fewer in number, the grains of iron accordingly pack more closely together, which is another way of stating that the contraction is greater. Castings with much graphite are termed 'soft' because the flakes of graphite lying betwixt the grains of iron assist the parting of these asunder when the iron is machined or filed. Highly graphitic iron is weak as well as soft. Each particle of graphite weakens the general body, and, when these are numerous, readily assist to form lines of fracture.

"In many pig-irons and heavy sections of castings the graphite is quite visible to the unaided eye, and does, in fact, give grey iron its grey appearance. Combined carbon and graphitic carbon may be made practically interchangeable under suitable conditions. The presence of sulphur, the absence of silicon, or quick cooling of the metal will each or all of them cause the greatest part of the carbon to take the combined form. Low sulphur, with silicon present to the extent of 3½ to 4 per cent. with slow cooling will cause almost the whole of the carbon to take the graphitic form. Grey iron has the greater part of the carbon existing as graphite, mottled iron has the carbon fairly well divided betwixt graphite and combined carbon, and white iron has the carbon wholly in the combined form. Each of these appearances is due to the chemical constitution of the metal, plus the rate at which the metal has cooled. As combined carbon increases, so does the hardness increase, and so also the strength increases up to a certain point, maximum general strength being reached when combined carbon of about 0·6 per cent. is present. With smaller percentages that 0·6 per cent. the iron is softer, is more flexible, and has a lower breaking strength. With percentages of combined carbon higher than 0·6 per cent. the iron is more rigid—that is, deflection is decreased, but the breaking strain is higher.

"The combined carbon in small castings is almost always greater in amount than in large castings, and this is due to the quick cooling of the small castings. This quick cooling of small castings readily causes the combined carbon to be in such excess as to make the casting appreciably hard, and sometimes chilled in parts. This is neutralised by increasing the silicon and so increasing the expellent effect silicon has upon carbon, and as a first effect makes it assume the graphitic form. The graphitic form, as we have seen, means softness.

"*Silicon.*

"The influence which silicon has upon the quality of cast-iron was wholly misunderstood until Professor Turner made his memorable investigations and experiments. Up to that time silicon was believed to be a hardening agent at all percentages, but now we know that it begins to harden iron only when 4 per cent. and over is present. With less than 4 per cent., silicon acts wholly as a softener. It does so by causing the carbon to take the graphitic form as already mentioned. It is not absolutely true that silicon and sulphur exclude one another, though it is seldom one finds high sulphur and high silicon together in the same iron.

"Hudson has shown that in 'glazed' iron containing 4 to 5 per cent. of silicon, the 'glazing' is due to an appreciable quantity of sulphur present. One important effect silicon has, is that of lowering the solubility of iron for carbon. Iron containing 4 to 5 per cent. of silicon seldom has total carbon over 3 per cent., and low total carbon, as we have seen, increases shrinkage.

"There is reason to believe that no free silicon is present in iron in the same way that carbon exists as graphite. Silicon and iron, however, form a com-

pound somewhat analogous to that formed by carbon and iron, the carbon being, of course, that termed combined carbon. The silicon-iron compound was, until very recently, considered to be structureless. Hudson has, however, isolated the silicon-iron compound, and under a microscope magnifying 1,800 times, has shown that the crystals take a cubical form.

"One other important function silicon performs is that of increasing the solubility of iron for gases. There are gases present in all melted metals, and trouble ensues when the melted metal, when cooling down, begins to expel these gases, and so porous castings, or if it be steel, porous ingots, result. Silicon assists the retention of these gases until the metal has set, and so porousness is largely avoided. Silicon and aluminium have a very similar action in keeping the gases dissolved in the metal. Silicon has the advantage over aluminium in so far as it may be bought in the pig-iron up to 5 or 5½ per cent. without any increase of price. In fact, these high silicon irons may sometimes be had cheaper than iron with a normal quantity of silicon.

"*Manganese.*

"Manganese is said by Ledebur to have the effect of hardening cast-iron, but in ordinary grey irons I have never observed that to be the case, even when manganese reaches 1¾ per cent. When iron contains 10 to 20 per cent. manganese, in the case of spiegeliesen, or 80 to 90 per cent., in ferro-manganese, then undoubtedly the very great hardness is due to excess of manganese. Scotch pig-irons have a reputation for their capacity to carry scrap without hardening, and Scotch irons are usually high in manganese. The sulphur present in iron is largely rendered inert or neutralised if other irons containing appreciable quantities of manganese be added to the mixture. The manganese and sulphur combine as manganese sulphide, Mn S, and this passes largely into the slag. Any manganese sulphide which remains mechanically mixed throughout the iron is said by Stead not to harden the iron. Considered from this point of view, manganese is a softener of iron, seeing it removes sulphur which would otherwise undoubtedly harden it. Manganese increases the absorbing power of iron for carbon, and in this respect has an opposite effect to silicon, which, as we have seen, lowers the power of iron to dissolve carbon. That manganese increases the carbon dissolved in iron is proved by the fact that ferro-manganese, which, as already stated, contains 80 per cent. or thereby of manganese, contains from 6 to 7 per cent. carbon, as against 4 per cent. or so in grey cast-iron. It is to be noted that the effect of manganese towards increasing the power of iron to dissolve carbon is not so great as the influence of silicon in the opposite direction. Silicon-spiegel is an iron containing notable quantities of silicon and manganese, and is used to make steel castings free from honeycombing. Holgate gives an analysis of this iron containing silicon 15·94 per cent., manganese 24·36 per cent., and total carbon only 1·20 per cent. The function of silicon-spiegel in improving the quality of steel castings consists in the silicon keeping the gases in solution, and the manganese, having a great affinity for oxygen, combines with the oxides interspersed throughout the mass of metal, and goes into the slag as oxide of manganese.

"It is probable that at the temperature of molten cast-iron, such an affinity of manganese for oxygen is not so active. That it has some effect in reducing the oxides present in molten cast-iron is very probable. It is certain that irons containing manganese are less likely to have the carbon and

silicon oxidised during melting in the cupola. Manganese is more readily oxidised than iron, silicon, or carbon, and in this way manganese is distinctly beneficial.

"*Phosphorus.*

"Phosphorus plays an important part in the melting, casting, and in the structure of cast-iron.

"Phosphorus is present in all cast-irons, except in the case of hematites, and it is not always absent from them. Up to 1·70 per cent. the phosphorus is combined with iron, as phosphide of iron, this being the phosphorus eutectic or mixture of phosphorus and iron having the lowest melting point. Phosphide of iron has a most marked influence on the rapidity of melting, and also on the cost of melting. Turner says that when melting iron it is probable that sulphide of iron is the first compound to melt. Even if that were so, seeing that iron when charged into a cupola should not contain more than 0·06 per cent. sulphur, the influence of the sulphide towards lowering the melting point of the whole mass of iron cannot be very marked. There is very little difference betwixt the sulphur contents of hematite and grey irons; but there is a very marked difference betwixt the temperatures at which they are melted, and that difference is undoubtedly due to the higher percentages of phosphorus in grey irons lowering the melting point. That phosphide of iron has a low melting point, and that it melts *within the iron* before the mass of iron has given any pronounced sign of fusion, was proved by Stead in the very striking experiment already mentioned.

"This phosphide of iron then by becoming readily fluid assists very materially the fusion of the iron as a whole, and lowers the melting point of the whole. The melting point of a compound or alloy is almost always lower than the mean of the melting points of the individual constituents. Let us consider what takes place when melting hematite iron. There being no phosphide of iron, and not much sulphide of iron present to melt at low temperatures, the heat of the cupola has to go on increasing until the silicon and carbon compounds melt at probably several hundred degrees of temperature higher than when melting a phosphoretic iron. It will thus be seen that phosphoretic irons may be melted with a coke consumption that would be quite impossible were hematite irons concerned. No credit then is due to one who melts these irons cheaper than what another does when melting hematites or low phosphorus irons.

"Nor does any discredit attach to the higher coke consumption of one melting the latter. The melting point of each class of iron is fixed, as we have seen, by the presence or absence of compounds having low melting points, and of these phosphide of iron is the most important. Phosphoretic irons run fluid, and castings made from these take on a nice smooth skin. The fluidity arises from the phosphide of iron having a low melting point, and the smooth skin arises from the iron not having an erosive or 'searching' action on the mould. This is owing to the phosphoretic iron being fluid at a temperature at which a non-phosphoretic iron would be, if not solid, pasty. Unfortunately phosphoretic irons do not continue their beneficence further than being melted and cast. Castings containing from 1¼ to 1½ per cent. of phosphorus do not readily resist shock, and such percentages have a very weakening effect in general. If in barreling castings, or afterwards in delivering to customers, breakages are in excess of what they ought to be, then look to the phosphorus. For highest strength have phosphorus 0·20

to 0·40. For fluidity, combined with strength, have phosphorus 0·70 to 0·90. For fluidity with fair strength you may go to 1 per cent., or very slightly over.

"*Sulphur.*

"There is no constituent of iron which exceeds the active influence of sulphur. That influence is, unfortunately, almost wholly not beneficial under ordinary conditions. Hence the anxiety of ironmasters and foundrymen to have the sulphur as low as possible. A high temperature in the blast furnace gives the conditions which are favourable for the production of an iron having high silicon and low sulphur. If, through accident or bad management, the temperature of the blast furnace be allowed to fall, then a large percentage of the sulphur passes into the iron. If the blast furnace remained at a high temperature, almost the whole of the sulphur would go into the slag and remain there, which is, in fact, the normal condition of things. Occasionally, however, the foundryman gets iron which ought never to be sent out, and in an iron of reputation I have found as much as 0·13 per cent. At the very worst it ought not to have been over 0·06 per cent. Even hematites occasionally reach 0·06, and are probably irons which were intended for acid Bessemer steel-making, but, being too high in sulphur for that purpose, were sent to the foundry. These facts show that neither irons of reputation nor irons supposedly pure are to be accepted as being consistently always of one quality, and that the best. Their producers would not be like the rest of the world if they never made mistakes. It is the business of the foundryman to see that the results of such mistakes are not passed on to him. The sole and only way by which the foundryman can protect himself is to buy by analysis, and to see that he gets the quality he wants and intends paying for.

"Sulphur, then, requires strict watching for the following reasons. It is present in the iron as sulphide of iron Fe S, and has a very marked influence on the carbon by making it take the combined form, and combined carbon means hardness. Sulphur also increases the contraction of iron, and greater contraction gives greater liability to fracture when cooling. Phosphide of iron has also the fatal quality that it gives out gases as it and the iron containing it fall in temperature towards the setting or freezing point, and so cause unsoundness. Probably it will have been noticed by some of you that when a ladle containing a small quantity of dull iron is brought back to the cupola it often smells strongly of sulphur, although when hot the presence of sulphur was not noticeable.

"There are two, or perhaps three, ways of dealing with sulphur. The first and best way is not to put it into the cupola, and in this direction a close watch has to be kept on the contents of sulphur in the coke. However, there must always be some sulphur in both iron and coke, and its influence may be considerably lessened by the use of pig-iron containing manganese, as already explained, the manganese combining with some of the sulphur to form manganese sulphide. Blast-furnace men are able to use a coke containing 1½ per cent. sulphur, and yet have only 0·03 per cent. in the iron, but that is by the use of large quantities of limestone.

"This is not permissible to foundrymen, as they work with very much lower temperatures, and highly-basic slags are viscous, not fluid, at cupola temperatures.

"The foundryman, then, has very limited power to lessen the effects of sulphur. In the ways indicated, and by the use of high temperatures available to him, and so increasing to the highest degree the sulphur-combining

powers of the slag, and by melting hot metal, he practically exhausts the means at his disposal to counteract the evil effects of sulphur. Fluxes which have not lime as one of the components may make a fluid slag, but they have no power to lower the percentage of sulphur in the iron by carrying it into the slag. Such an influence is reserved only for fluxes containing lime, and a lowering of sulphur is best accomplished by a flux made from a mixture of limestone and fluor-spar.

"*Influence of Oxides.*

"That oxides have a considerable influence on the solidity and strength of iron there is very little doubt. I have often watched melting proceed in the cupola, and seen a small runlet of molten iron lodge on the top of a piece of coke opposite the tuyere. Almost instantly a black patch of oxidation caused by the blast of air appears on the surface of the iron; then all is washed away into the main body of melted iron by a subsequent dripping of the iron. This oxidation of iron and its constituents, excepting phosphorus, is taking place in the cupola wherever free oxygen is present, and is most active immediately in front of each tuyere. Part of the oxides so formed, goes into the slag, but part also goes into the iron. Dr. Moldenke, the accomplished secretary of the American Foundrymen's Association, has paid considerable attention to this branch of metallurgy, and has shown that these oxides weaken the iron very considerably. He recommends the use of titanium as a de-oxidising agent, having shown by experiment that considerable added strength is obtained by its use. This is a subject and line of thought which might well repay us to consider.

"*Conclusion.*

"In drawing to a conclusion, I would say that, while there is ample room for improvement in the industrial life of Britain, there are also some hopeful features. Some time since I met an American gentleman having a most extensive experience of American works and workshop practice. He had just been through a number of British workshops, and he assured me that from what he had seen there was undoubtedly a thorough but quiet revolution going on in British methods of work, and that from what he had seen and heard from manufacturers, they had no intention of lagging behind any other people whatever. He also said that he feared many Americans were getting into the frame of mind the British were just leaving. That consisted of a belief that they were so far in front of all the rest of the world they could afford to rest a bit until other folk came up. Whether that be so or not, we find at home an alertness and adaptability not visible a few years ago.

"One great hindrance to advance is the extent to which sport and the curse of betting occupy the minds of our workmen. When I see a workman rush at the dinner-hour to secure his favourite betting paper, I always put him down in my mind as probably a poor workman, and he is certain to be a bad servant.

"No man can serve two masters. Industrial success or sport and betting must go to the wall. Which is it to be? Let us cast away the hindrances that beset us, and by depth of knowledge, clearness of vision, and adaptability to new methods and conditions of work prove ourselves able to hold our own in any field of industry.

"May we as a nation meet the changing conditions of the times by casting from us the hindrances of idleness and of ignorance, and by discipline of mind and body carry forward the flag of industry and of progress as proudly and successfully as ever it has been carried in the past."

PORTRAITS OF PIONEERS.

IX.—Alderman Richard Williams, J.P.

ALDERMAN RICHARD WILLIAMS—the Grand Old Man of the Black Country—was born in Liverpool on January 3rd, 1817.

After having an excellent education at a private school in his native city, he was, at the age of fourteen, apprenticed to one of the large Liverpool engineering firms, where he remained for eleven years. During that period he supplemented the valuable training and experience acquired in the works by diligent attendance at the evening classes at the Mechanics Institution. Amongst his teachers was Mr. Fox—afterwards Sir Charles Fox, the eminent engineer.

In 1841 Mr. Williams became agent for a Smethwick firm, and in 1844 he left Liverpool on being appointed by the Patent Shaft and Axletree Company assistant manager at their Brunswick Works, Wednesbury. He became general manager, and finally managing director. Under his management the concern grew rapidly, the extensive works of Foster, Lloyd & Co. were acquired, and new branches of trade were developed—including a very high-class trade, which required material of such a superior quality that Russian iron from special ores had to be used. During the Crimean war the supplies of Russian iron were stopped, and when the war was over Count Demidoff opened negotiations for resuming the shipments. Early in the interval, however, Mr. Williams had led and encouraged his men in carrying on improvements in iron-making, sometimes spending days and nights together watching the results. As they succeeded in producing the high quality demanded no more Russian iron was imported to his works.

The foreign iron cost £17 per ton; the improved Wednesbury iron cost £7 per ton, and many hundreds of thousands of pounds were saved. It was the most noted improvement of the time in the puddling process, and the new method was continued till high-class steel made by modern methods had established a firm position.

About eleven years ago Alderman Williams resigned the active management of the Company. His splendid qualities had developed the business and brought it into the front rank of iron and steel companies—one which has satisfactorily executed important contracts in all parts of the world.

Alderman Richard Williams, J.P.

Alderman Williams, now in his eighty-eighth year, is the sole survivor of that brilliant band who originated the Institute of Mechanical Engineers fifty-seven years ago, and he is one of the few remaining founders of the Iron and Steel Institute. Lately he gave to the Wednesbury Free Library his valuable complete set of the Transactions of both of these societies.

He has always been a liberal and cheerful giver to the best institutions in the town of his adoption and the surrounding district.

He was elected first Mayor of the Borough—which he practically created—and is its only free burgess. His individuality is impressed on the many committees in South Staffordshire, of which he is a useful and highly appreciated member.

WALTER MACFARLANE, F.I.C.

MACHINE-CAST PIG-IRON.*

BY J. P. ROE.

BROADLY, the greater number of constants that can be introduced into a given operation the more uniform will be the result. Therefore, given an iron containing a known and uniform amount of the various metalloids, it is possible to obtain a product of relative uniformity; and, what is of the greatest importance, a basis for the associated ideas of cause and effect.

As an illustration of the extreme crudity of grading by fracture, the following analyses are submitted of sand-cast pig-irons shipped by the blast-furnaces as grey-forge irons and mottled irons respectively, and similarly graded by fracture by our chemist. The analyses of these irons showed :—

GREY-FORGE.

Sulphur. Per Cent.	Silicon. Per Cent.
0.035	2.06
0.140	0.65
0.016	0.61

MOTTLED.

Sulphur. Per Cent.	Silicon. Per Cent.
0.166	2.00
0.236	2.40
0.057	0.24

These extreme variations are by no means as uncommon as might be supposed; and they are representative, although in less degree, of sand-cast pig-iron in general. Such variations explain the wisdom of the common practice in puddling of mixing a number of brands of pig-iron together, the probability being that only one brand would get "off" along certain lines at a given time, and that this would be neutralised wholly or in part by the others.

The advantages of machine-cast pig-iron for mill purposes are :—(1) greater fusibility of a given grade, due to the absence of the relatively infusible coating of silica; (2) reduced loss, due to the same cause; and (3) relatively uniform chemical composition.

I wish to emphasise the importance of uniformity in chemical composition. The analysis of a pig that is representative of a shipment is of value, while the analysis of a pig that is not representative is valueless. A sand-cast pig is less likely to be representative than a machine-cast pig. Another feature worthy of note is that an exact knowledge of the chemical composition of a pig-iron is of more value than a too narrow limitation of the individual components. This statement is fully proved by the relatively high phosphorus and sulphur of certain brands of celebrated finished irons. In closing, I beg to call attention to an argument frequently made that because the presence of certain metalloids in large quantities is disastrous, the presence of the same metalloids in small quantities is proportionately disastrous. This deduction is not true, for the reason that the presence of a small proportion of certain metalloids is often of positive good to the iron.

*Abstract from the Proceedings of the American Institute of Mining Engineers.

The Tees Railway and Engineering Works, Cargo Fleet, Middlesbrough, were offered for sale by public auction recently, but not a single bid was made.

ANNEALING CASTINGS BY POWDERED COAL.

THE largest agricultural implement works on British soil are those of the International Harvester Company at Hamilton, Ontario. The foundry at these works, which mainly turns out malleable castings, presents many features of interest, but the purpose of the present article is to describe the system in use of annealing the castings by means of the flame from the combustion of powdered coal. As this is somewhat novel we describe this process in detail, including the handling, storage, crushing, and pulverising of the coal. The building used for the storage of coal somewhat resembles a grain elevator, and is 80 ft. long, 18 ft. wide, and 68 ft. high. It has a capacity for 600 tons. A continuous V-bucket conveyor travels beneath the hoppers of this building up to the top, across the top past the coal storage bins and down the other side. A switch track adjoins the building, and coal is taken into the building in one of two ways: If the coal arrives in a hopper waggon it is dumped through a grating into a pit, whence it is conveyed to the bins by Webster apron conveyor, which dumps it into the continuous V-bucket conveyor, but if the coal arrives in an ordinary coal waggon it is shovelled directly into chutes leading to the bucket conveyor.

The building contains two bins, one above the other, the upper bin emptying into or through the lower and the lower emptying into the V-bucket conveyor. At one end of the pent house on top of the elevator is a 20-ton storage bin. This bin receives its supply of coal either direct from the car or from the main bins, the passage of the coal into either receptacle being controlled by means of automatic gates in the trough.

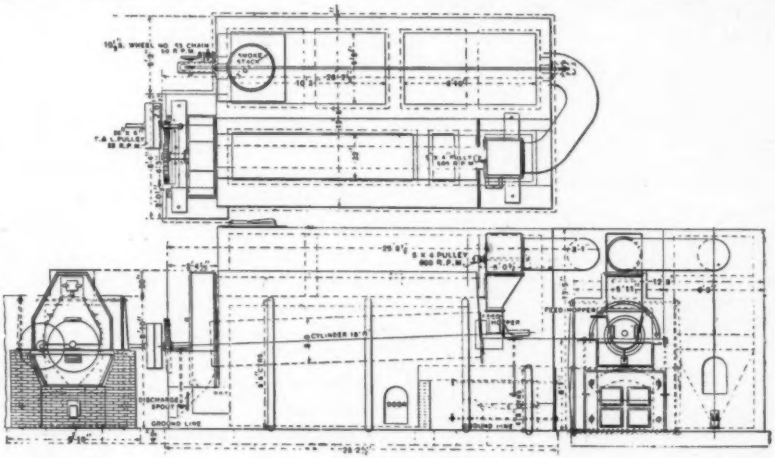


FIG. 1.—COAL DRYER.

The storage bin lies several feet above an Aultman 30 by 18 in. coal crusher, and from it coal is conveyed automatically into the coal crusher, the supply of coal being controlled in proportion to the speed of the crusher.

The crushed coal descends from the crusher by gravity through a trough to a single cylinder, direct heat, rotary dryer shown in Fig. 1. This dryer is so constructed that the products of combustion can be made to pass through the materials to be dried, or by changing

a damper, can be made to pass on the outside only and not come in contact with the material to be dried. The cylinder is 36 in. in diameter and 18 ft.

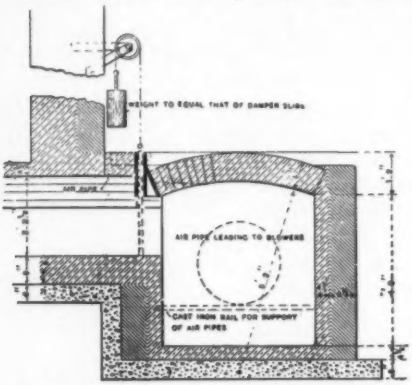


FIG. 2.—DETAILS OF FLUES, SHOWING METHOD OF HEATING THE AIR BY PLACING PIPE WITHIN MAIN FLUE.

long, made of ¼-in. steel plates the full length of the cylinder, without cross seams. It is supported on steel shafts at both ends, fastened to steel spiders, which are riveted to the shell of the dryer. Its speed is about five evolutions per minute and its capacity from 60 to 80 tons per day.

The coal enters the hopper at the front end and is slowly conveyed into the drying cylinder and passes slowly through it, being elevated and cascaded continually while passing through and coming out at the rear spout in a dried state. The fire doors are in the front end; the fire passes all around the cylinder, then up through a steel flue, and is returned through another flue over the dryer and out through the fan. If it is desired to pass the products of combustion through the material the damper can be immediately changed so as to pass the hot gases and flame first around the outside, then through the cylinder, coming out of the breeching at the front end.

It will be readily understood that a little better result can be had by passing the products of combustion through the material; this, however, is not often done, on account of the danger of igniting the coal dust, and is only done when the coal is unusually wet.

The moisture, together with from 2 to 5 per cent. of the fine coal in form of dust, is taken in at the front end of the dust room, passes down around the first wall of brick, then up over the second wall, then down under the third wall, then upward and out at the fan or stack; the dust in the meantime has settled to the bottom of the dust chamber, which is hoppered. In the bottom of this hoppered chamber is a drag chain conveyor for taking out the dust as fast as it has formed and conveying it to the pulveriser.

The dried coal drops from the dryer into a bucket elevator at its lower end and is elevated 15 ft. to the hopper on the top of the Raymond pulveriser. This pulveriser consists essentially of two castings—the base and the top, or housing, with a vertical centre shaft to which is keyed a spider. Rolls are pivoted on to the spider similar to the manner of attaching the arms of a governor, and when the shaft revolves the centrifugal force holds the heavy rollers against the sides or "bull ring" of the machine, and coal introduced into the machine is quickly reduced to powder between the rollers and the bull ring. The mill is supplied with an automatic feed, so that if the feed hopper is kept full the mill requires practically no attention.

The central shaft is supported on a step bearing underneath the mill, which is supplied with an adjusting screw that enables the operator to raise or lower at will the central shaft which carries the spider and the rolls, in order to keep the rollers even with the top of the bull ring.

The spider is keyed on to the central upright shaft, and when the power is

applied to the countershaft the bevelled gears set the central shaft revolving, which, of course, revolves the spider and the rolls pivoted on to the spider after the fashion of a set of governor pulleys on an engine. The centifrugal force and the fact that the rollers are pivoted to one side of the centre cause a tremendous friction and pressure to be applied at the point of grinding contact between the rollers and the bull ring. The rollers are made of cast iron, chilled.

The coal is delivered to the grinding surface from the hopper by means of a plough set directly in front of the roller in such a manner as to insure the passage of the coal under the roller, and then throwing it up on to the screen surrounding the mill. The ploughs are fastened to a support which is keyed to the central shaft, so that the ploughs travel at a comparatively slow speed, which is a novel feature, as most of the mills heretofore have fastened the ploughs to a journal shaft which runs at a very high speed.

The pulverised coal, after passing through the screen, is collected in sheet iron hoppers, which discharge it into a conveyor by means of a number of perforations that all radiate toward the points of discharge into the screw conveyor underneath the floor level.

The automatic feed is easily changed by adjusting the screw in the pitman which slides in a slot or eccentric, so that the pawl and ratchet can be made to feed anywhere from one to seven notches. This is also a valuable feature, as a uniform feed is very important to any grinding mill.

The pulveriser has a capacity of 30 tons per day, and the coal dust from it drops into a boot and is lifted diagonally by a bucket elevator to a horizontal flight conveyor propelled by a No. 3 double bushed chain, running in a steel trough, serving 12 storage bins, one for each annealing furnace. This conveyor is driven by a motor which actuates a 60 ft. shaft running the length of the battery of ovens. From each of these hoppers the dust is fed forward toward each furnace through a 4 in. horizontal pipe by means of a helical conveyor. At the end of this trough the dust falls by gravity through a nozzle into another 4 in. pipe, through which it is blown into the furnace by a blast of air. To prevent chilling of the furnace this air is heated to a high temperature before being admitted. This is done by passing the supply pipe, as illustrated in Fig. 3, through the entire length of the main flue.

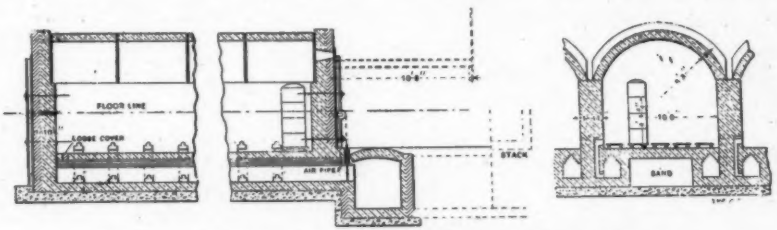


Fig. 3.—Annealing Oven—Longitudinal and Cross Section.

To start the fire, this mixture of air and pulverised coal is lighted by waste saturated with oil, placed immediately in front of the discharge into the furnace, and the mixture burns with a clear blue flame somewhat resembling a gas flame.

The ash resulting from this combustion is deposited largely in the furnace itself, and is removed from the same at the end of each heat before the furnace is recharged. This is done by shovelling the ash into suitably designed steel boxes

which are lifted out of the ovens by the travelling crane and deposited in a convenient location to be hauled away. The small part of the ash which is deposited in the flue of the chamber is removed by means of a steam jet inserted at one end of the flue. When the steam is turned into this jet the dust is blown out of the flue. In actual practice it is found that there is practically no ash deposited on the sides of the annealing pots, and the ash which is deposited on the top of these pots is in no way detrimental to the process.

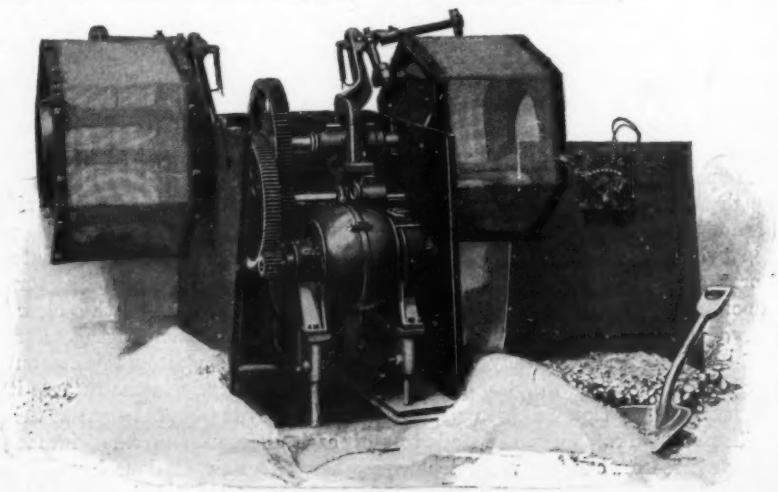
The entire apparatus from the point where the flight conveyor discharges the pulverised coal into the 12 storage bins was designed and erected by the Sturtevant Company.

The use of coal dust for annealing furnaces not only effects a saving in fuel, but shortens the annealing process by at least 24 hours and gives a higher average quality of casting because of the greater uniformity which can be maintained by means of the coal dust as compared with any other fuel.

Each of the 12 annealing ovens is 35 by 10 ft. inside measurements. The top, or roof, of the oven is built up from a series of six selections, or "bungs," each section being built up, as shown in the illustrations, from 9 in. I-beams, curved to a 6 ft. radius, as shown in the print. These I-beams carry a stratum of fire brick 9 in. thick on their under side and are tied together transversely by means of bars, riveted at the intersections. Each section, or "bung," has a heavy steel eye at the top, which is engaged by the hook of the crane and is by that means lifted out of place and set over on to an adjoining oven. This removable feature of the oven tops is brought into play both in loading and unloading ovens.

ELECTRICALLY-DRIVEN SAND SIFTER.

THE annexed cut shows a Lundell motor geared [illegible] sand sifter for foundry work. It is not so long ago that the use of an electric motor for such arduous service would have been considered impossible. The compact arrangement of the motor and sifter will be shown from the illustration, which is so self-explanatory that no further comments are necessary.



ELECTRICALLY-DRIVEN SAND SIFTER.

CHEMICAL SPECIFICATIONS FOR PIG-IRON.

IN a discussion of the Paper of Mr. Edgar S. Cook, read before the American Institute of Mining Engineers, Mr. James Gayley, the first Vice-President of the United States Steel Corporation, states his views as follows :—The main thing that is sought after is that all purchases of pig-iron shall be made by analysis. This is done already in special lines, as in the manufacture of various grades of steel in which phosphorus, silicon, and sulphur are specified within narrow limits, and I quite agree that specifications which are over-rigid in unessential particulars should be avoided, as they defeat their own purpose because unreasonable requirements permitting no variation are practically not fulfilled, and it is impossible to specify grade and analysis in an apparatus so variable in its results as a blast-furnace.

What is desired for the consumer is an honest grade of iron, and that is obtainable far easier through a stipulation as to analysis than as to grade. I do not quite understand, according to the specifications of the several grades of iron, why the committee has only specified silicon and sulphur, while the phosphorus, which has such an important influence in foundry operations, should have been omitted. The different makers produce a brand of iron which contains phosphorus varying within certain limits, but it becomes necessary for the consumer to be acquainted with the character of the brands that are on the market with respect to their content in phosphorus. It seems to me that it would be far better to stipulate by some brand-name an iron containing a certain percentage of phosphorus, as, for instance, an iron containing from 0·25 to 0·50 per cent. phosphorus, be designated, say, as "Alpha grade;" from 0·50 to 0·75 per cent., "Beta grade;" from 0·75 to 1 per cent., "Gamma grade," and from 1 to 1·25 per cent., "Delta grade," etc., so that a consumer ordering iron can specify No. 1 or No. 3, Alpha or Delta grade, as will suit his requirements, and irrespective of the furnace company from which he purchases, is assured of obtaining an iron that is practically uniform as respects silicon, sulphur, and phosphorus.

This sytem of grading is in use at the mines controlled by the United States Steel Corporation in the Lake Superior region, in which the name of the grade of ore beginning with A represents the best Bessemer grade; the word beginning with B represents non-Bessemer grade, and the one beginning with C represents a lower grade of ore than either of the other two, as, for instance, at the Mansfield mine the various grades are designated as Atfield, Barfield, Clearfield, and at the Buffalo mines the grades are Alamo, Buffalo, Cameo, the termination of the word being used to designate the mine in addition. This suggests to me that something on a similar basis might be used to advantage in the grading of foundry iron.

Another point has been brought out in a discussion of iron for foundry purposes, and that is that much trouble may arise from the content of oxygen. It occurs to me that much valuable time is lost in looking for some unusual content in pig-iron, to which great and mysterious influences are attached, whereas the conditions under which iron is remelted, the content of sulphur in the coke, and the amount of scrap that is mixed with the iron, about which generally the founder knows little or nothing, exert a far greater influence.

I recall an experience I had when connected with the Carnegie Steel Co., in endeavouring to find out the superiority of charcoal-iron for the making of car-wheels. A certain grade of charcoal-iron which contained about 0·75 per cent.

phosphorus had given excellent results in the making of car-wheels, and inasmuch as we had on hand a stock of ore exceedingly low in phosphorus at one of our furnaces, we concluded to make some iron on a very low temperature of blast that would contain about 0·03 per cent. phosphorus. This iron we made with a hot-blast temperature of 300° Fahr., as compared with the charcoal-iron with 500° Fahr. The resultant metal contained, approximately, as I recollect, the same percentage of silicon and carbon as the charcoal metal, but it did not yield the same results in the manufacture of car-wheels.

Before making this experiment I had consulted with Mr. Wm. Metcalf, who had long been known as a very careful investigator in iron and steel metallurgy, as to the superiority of charcoal-iron, and he had suggested that it was perhaps due to the absorption of nitrogen—that he had found a very great variation in content of nitrogen in various steels, and that the charcoal-iron with a cold blast would absorb less nitrogen than iron made with a hot blast, irrespective of whether the fuel was charcoal or anthracite. In order to test this question, the low-phosphorus iron was manufactured with a blast temperature of 300° Fahr. Samples of this low-phosphorus iron and the charcoal-iron, and of our standard Bessemer iron, and a piece of basic iron taken indiscriminately from a pile containing about 0·50 per cent. phosphorus, were sent to Prof. Langley for determination of nitrogen. We looked forward with keen interest to the return from these samples, expecting that the low-phosphorus and the charcoal-iron would show so much better, but instead the basic iron, from which we expected nothing, was materially lower in content of nitrogen, and was made perhaps with the highest temperature of hot blast. Since that time I have regarded with more or less indifference the claims that are put forward respecting the great influence that is exerted by the gaseous contents in pig-iron. Both the steel maker and the foundryman will obtain far better results when pig-iron can be made with far more uniformity than is possible under present conditions. In a furnace using Lake Superior ores it requires, approximately, 7,200 lbs. of raw material and 11,700 lbs. of air to produce a ton of iron. The raw material is controlled now within a variation of 10 per cent., whereas the air will vary in a single day as much as 100 per cent. Experiments are now under way which will demonstrate during the current year what increase in uniformity can be obtained in the blast-furnace by making the quantity of air consumed per ton of pig-iron as uniform as that of the raw material.

PIG-IRON IN ITS COMMERCIAL ASPECTS.*

By F. M. Thomas.

THERE are several modes of casting pig-iron, the old and most general method being to tap the molten iron direct from the blast furnace into a sand bed, another way, but not one commonly used, being to run the iron into ladles and from them into ingot moulds. Pigs made by the latter process are termed machine-cast pigs. Where sand pig beds are used, the molten metal runs from the tap hole of the furnace into channels or feeders moulded so as to conduct the stream of metal to the different ranges of pig moulds. These feeders, or as they are termed, "sows," being of a larger section than the pig-iron, take a longer time to cool, and are therefore usually softer, the fracture having a more open grain than the pigs

* Abstract of a lecture delivered by Mr. F. M. Thomas, of Messrs. Belliss & Morcom, Ltd., before the Birmingham Metallurgical Society.

fed from them. This is due to the separation of carbon as graphite during the cooling.

Buyers as a rule do not object to a reasonable proportion of sows in a consignment of pig-iron, since as they are rather softer they will take up more scrap in re-melting. Usually, however, they contain a quantity of dirt and slag, so that an undue proportion in a single parcel is not desirable from a purchaser's point of view, as they require more flux, and would not be economical in coke consumption, which is an important consideration in iron founding. It has been claimed for machine-cast pig-iron that an economy of labour is effected, and that the pigs being quite free from sand require less flux, and consequently, less fuel, when re-melted.

The amount of sand which clings to ordinary cast pig-iron varies very considerably, and although a good deal shakes off in transit, there is invariably a quantity adhering to it when it reaches the buyer. This not only leads to disputes as to weight, but also to loss and expense in melting.

Like everything else that offers advantages, there are, however, disadvantages to consider, and with machine-cast pig-iron the drawback is the tendency of the iron moulds to produce a chill, rendering the metal hard and close-grained, and not so suitable for the production of soft castings as the grayer iron from sand beds. Moreover, with machine-cast pigs less scrap can be re-melted. It is, of course, quite possible to get chilled iron from sand beds, but this is generally the result of casting in damp weather.

The ordinary classes of foundry and forge pig-iron produced both in this country vary little in general appearance, the pigs usually running about 3 ft. 6 in. to 4 ft. long by 4 in. D section, and weighing roughly 1 cwt. each. For crucible casting, as in malleable iron founding, they are the same shape, but of a much smaller size, being about 2 in. across the section by about 3 ft. long, and weighing approximately 40 lbs. each. Swedish pig-iron is usually supplied in the form of chilled slabs, but for foundry work it is cast both in long pigs nicked at intervals to facilitate breaking, and also in smaller pigs, much resembling our malleable pig-iron.

IRON FROM VARIOUS DISTRICTS.

At one time it was possible to tell with a reasonable amount of certainty what would be the chemical analysis of pig-iron made in different districts, because the ores used were obtained locally. Although in some measure this is still true, the statement would require modification, since in some localities—for instance, Staffordshire—many of the ironstone mines have been exhausted, and the ores now being used in the production of Staffordshire hot-blast pig-iron, instead of being mined in Staffordshire as formerly, are obtained largely from Oxfordshire, whilst much of the Derbyshire pig-iron is manufactured from ironstone obtained from the counties of Northampton and Leicester. The South Staffordshire cold-blast pig-iron is, however, still made from local ores, but the seams now only yield comparatively small quantities of ironstone, which vary somewhat in chemical composition from different localities, so that it is not always possible to get an absolutely regular analysis. The phosphorus in South Staffordsdire cold-blast pig-iron is low, usually about 0·3 to 0·5 per cent., and this is fairly constant, whilst the content of manganese varies from 0·25 to nearly 1 per cent. Yorkshire cold-blast pig-iron, from which is made some of the finest bar-iron in the world, is produced from ores obtained in the West Riding district.

Pig-iron which is designated non-phosphoric is that suitable for the manufacture of steel by the acid processes, *i.e.*, it contains less than 0·06 per cent. phosphorus. Some pig-irons contain too much phosphorus for use in the acid

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process and too little to be suitable for the basic, and cannot be used for either purpose. They are, however, useful in the foundry for the production of fine castings. The terms "all-mine" and "part-mine" used in connection with pig-iron, denote whether the iron has beon produced from "all-mine" ore, or part ore and part forge cinders.

Cinder pig is the commonest of all pig-irons. It is made by smelting calcined tap cinders in the blast furnace; it is white and hard, and contains a high percentage of phosphorus and sulphur. Staffordshire cinder pig is of better quality than that from other districts, owing to the quantity of manganese present, as this element tends to remove the sulphur, and thereby improves the quality of the iron. In this country grey pig-iron is graded according to fracture, the most open grained, which is also the softest, being termed No. 1, and, as the different degrees of hardness and closeness increase, the numbers get higher, to No. 6. No. 6 pig-iron has a very close grain, is very hard, and verges on mottled iron; indeed, some makers cease numbering at No. 5, that is, they call their hardest class of grey pig No. 5, and after this they designate it soft or hard mottled, spotted white, or white, as the case may be.

Pig-iron for Malleable Castings.

The pig-iron used for malleable castings is intensely hard, and is supplied in grades ranging from grey mottled to hard white. It is really a refined hematite pig-iron. For very thin work, such as nails, or say boot protectors, a No. 5 hard grey Cumberland hematite, containing about 1·4 per cent. silicon, may be used. As these castings are thin, they chill dead white, but the silicon being moderately high, allows the carbon to separate out into a modified form fairly quickly during the annealing, which in this case only takes about thirty-six hours. If the same iron were used for thick castings, they would be grey and weak. For thicker castings the pig-iron may be varied a little, according to the length of time for annealing; thus, a soft mottled pig, containing say 0·9 per cent. silicon, may be used for castings about $\frac{1}{2}$ in. thick, and would anneal in about four days, whilst longer annealing in this case would probably cause deterioration in quality. Still thicker castings require a harder iron, to prevent the graphite separating in the centre, and hard mottled or spotted white, about 0·65 per cent. silicon is used. When this is mixed with scrap from previous meltings the castings would contain about 0·5 per cent. silicon, and would require to be annealed at least seven days, the heat being maintained throughout the whole period, otherwise such castings would still be hard.

Typical Analyses of Pigs for Malleable Castings.

	Hard Grey. Per cent.	Mottled. Per cent.	White. Per cent.
Combined C. ...	1·9	2·5	3·2
Graphitic C. ...	1·8	1·2	0·3
Silicon	1·3	0·8	0·5
Manganese	0·35	0·3	0·25
Phosphorus	0·05	0·05	0·05
Sulphur	0·08	0·15	0·25

Grading of Pig-iron.

Nos. 1, 2, and 3 are the grades most commonly used as foundry irons, although frequently, as in the case of heavy castings for hydraulic work, or where very close-grained, tough castings are required, as for cylinders, rolls hydraulic castings, &c., No. 4 iron is used. There is, however, a much wider range in the grades of foundry irons than is suggested by three or four numbers; for instance, we get open and close No. 3, strong and hard No. 4, and so on. In America it is customary to classify the pig-iron according to the percentage of silicon in twelve different grades, ranging from No. 1, containing about 3 per cent. silicon, up to white iron with less than 0·5 per cent. silicon.

(To be continued.)

CURVED PIPE MOULDING MACHINES.

WHILE the manufacture of cast-iron water and gas pipe was one of the earliest branches of the foundry trade to become specialised, the moulding of the necessary fittings has not, until quite recently, received any marked attention. Nearly every pipe foundry of any pretensions is generally divided into two departments, the pipe foundry proper, where labourers of a special class do the moulding and core-making, and where the cost of this per ton of castings is very low, and the general foundry, where all special castings are made, in which journeymen moulders are employed. The tendency now is, however, to specialise the latter department by the use of special moulding machines.

Figs. 1 and 2 show the Lambert machine for making moulds and cores for curved cast-iron pipes. It will be seen to consist of a pit, at one end of which are two head blocks, between which are pivotted two hanger blocks, to which are secured the rear ends of a pair of parallel joists connected by spacing blocks. The shaft passes through slots in the hanger blocks, so that the pivotted point of the beams may be adjusted vertically.

Upon each side of the pit is a rail forming a track for two trucks. The rear truck carries a windlass connected by chains to the loose end of the swinging carrier, so that the latter may be raised and lowered as desired. The forward truck has upon it two vertical and parallel uprights, with vertical ways upon their forward faces; upon this is gibbed a vertically movable cross head on which are two horizontal arms, operated by screws to move them toward or from each other.

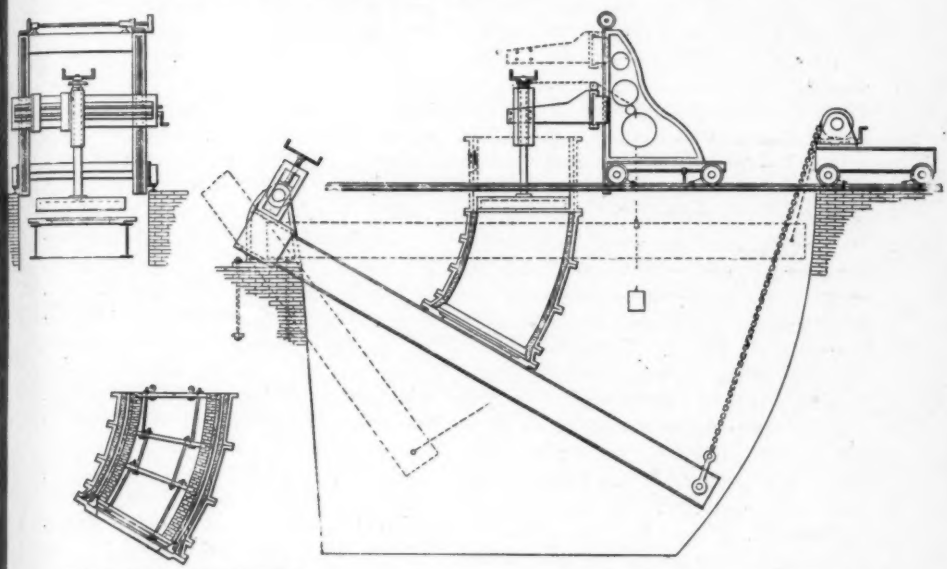


FIG. 1.—THE LAMBERT CURVED PIPE MOULDING MACHINE: PARTLY-FORMED MOULD IN POSITION ON MACHINE.

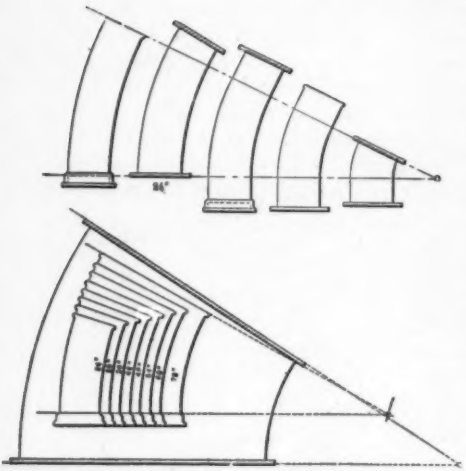


FIG. 2.—THE LAMBERT CURVED PIPE MOULDING MACHINE: DIFFERENT SIZED BENDS MADE WITHOUT PATTERNS.

By means of a hand wheel and gearing, two vertical screws in proper bearings, and engaging a cross-head, may be simultaneously operated to raise and lower the cross-head. Adjustably bolted to either of the arms is a vertical sleeve in which is journalled a crank-operated spindle, carrying on its lower end a shaper in the form of a flat circular disc, which has a diameter just equal to the outside diameter of the bend to be constructed.

Clamped upon the joists which form the carrier is a bottom plate (having construction similar to boring mill tables of iron-working machinery), and capable of being adjusted to any point on the carrier desired for a radius. Bolted to the face of this plate is the base of the mould or chill plate. On this is centred the flange or socket pattern of the bend to be cast; also to this base plate is secured a flask, preferably of two-part circular sections, for the mould. When this has been secured in place sand is rammed into the flask around the socket pattern or flange, and then the shaper is brought down upon the top of the socket; sand is rammed around the former or pattern, the carrier being gradually lowered as the ramming takes place. When the shaper comes to the upper edge of a flask section a second section may be clamped on, if necessary, and the operation of ramming sand continues while the carrier is gradually lowered. Should the pattern, while the sand is being rammed around it, refuse to clear itself from the sand, when the flask is being lowered, it only becomes necessary to revolve the pattern or former by means of the chain passing around the heaves which is keyed to the shaft that holds the former.

It will be observed that by the lowering of the carrier the shaper or pattern travels within the flask in the arc of a circle struck from the pivots of the carrier.

Where it is desired to make the upper or lower end of the mould straight—that is to say, without any bend—the pattern is then raised by screws in a vertical line and to a distance equal to the length of the straight end of the pipe to be cast, the carrier meanwhile remaining stationary (its downward course having been stopped by two stop chains, having been set to the desired degree, as indicated by a marker of degrees on the end of the chain drum mounted on the truck), it being understood that the operation of ramming the sand goes on as described.

When the mould has been thus completed it is removed from the carrier and set to one side; the socket pattern is taken out, the chill plate and base plate being left secured upon the carrier in the position it formerly occupied, and the carrier being drawn up to its horizontal position at the top of the pit.

The core is then built upon this same chill plate by placing therein a socket iron with interior bevel. A disc, with a bevelled edge corresponding in size and bevel to the interior bevel of the socket iron, is then placed within the top of the socket iron, and circular brickwork is

built up on it, the carrier being gradually lowered, and a ring-shaper, which is substituted for the mould-shaper, is used as a guide in forming the curvature of the brickwork. At intervals in the brickwork are placed discs, with their bevelled edges entering the brickwork, and tie rods are employed to unite and bind the same together; and in this way the brickwork of the core is built up in the same manner and upon the same curvature that the mould is made. Upon the top of the brickwork core thus made a plate is secured, which is provided with hoisting loops to enable the core to be lifted off bodily.

When the brickwork has been thus built up loam is applied to its exterior, and the ring acts as a shaper to dress off the sides by the raising and lowering of the carrier.

When the core has been thus completed and removed and the socket iron made up in the ordinary way, the mould is again centred on the chill plate and the core placed within it, by guiding it in from above and centring it upon the socket iron in the same position as made.

In making moulds and cores for pipe bends of different curvature it is only necessary to admit the chill plate to any point upon the carrier beams desired for a radius. The production of the mould and core in an upright position and its manner of construction permit of the production of a curved casting of uniform thickness without the use of chaplets or anchors. This machine is made by the Lambert Cast-Iron Curved Pipe Machine Company, Cincinnati, U.S.A.

Figs. 3 and 4 show a moulding machine recently designed by Walter E. Stuart, of the Co-operative Foundry Company, Detroit, U.S.A., which has for its object the simplifying of moulding special castings, so that these may be turned out with greater accuracy and despatch. With the Stuart machine a mould may be made in green sand, dry sand or loam, though with the larger class of castings the latter method will generally be found preferable, however many foundries may claim success with dry sand moulds for very large work. The machine under consideration is operated

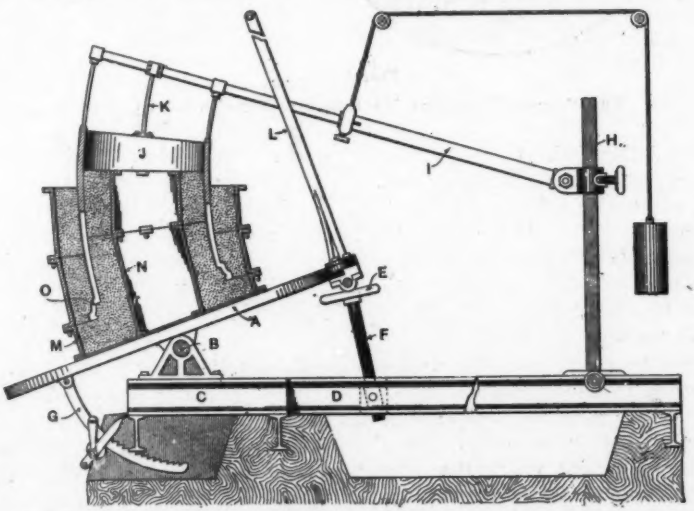


FIG. 3.—THE STUART MOULDING MACHINE FOR SPECIAL PIPE CASTINGS; SECTIONAL ELEVATION.

uniformly, no matter what method of moulding is adopted.

One feature of this form of machine moulding is that the outlay for patterns and core boxes is reduced to the minimum, as only a short section of the pattern of the required diameter is necessary, this being drawn upwards as the moulding progresses. The machine is provided with a tilting table A, swinging upon the shaft B, and mounted upon the beams C and D. E is a handwheel attached to the threaded shaft F, by means of which the table is tilted to the required angle. G is a support to assist in holding the table rigidly when the proper angle has been determined. Upon the spindle H is mounted the adjustable radius arm I, and to this is fastened the section of the pattern J, through the supports K, which prevents tilting of the pattern, and causes it to travel in a definite direction. To guard against lateral motion the upright guides L are provided.

As will be noted from the sectional illustration, showing the moulding of a casting in dry sand, the flask is divided into suitable sections, as is also the core barrel, around which the core is made. The core barrel is employed not only to give strength to the core, but also to save sand and labour in ramming up the core, as well as time in drying the mould. In making a mould a bottom plate is placed on the table A, on which rests the drag section of the flask M, and the lower section of the core barrel N. When the drag has been rammed up a joint is made and the patterns O, which forms the flange, is placed in position, and into this is lowered the sectional pattern J. The next part of the flask can now be lowered on to the drag, and as the making of the mould progresses other parts are added until the mould has the required length. The illustration shows joints made at each section of the flask and core barrel to facilitate handling in the drying ovens or on the floor. It is evident that both flasks and core barrels may be divided up as best suits the shop, and that several sections of the flask may be fastened together and treated as one unit, if facilities for drying and handling the mould permit this.

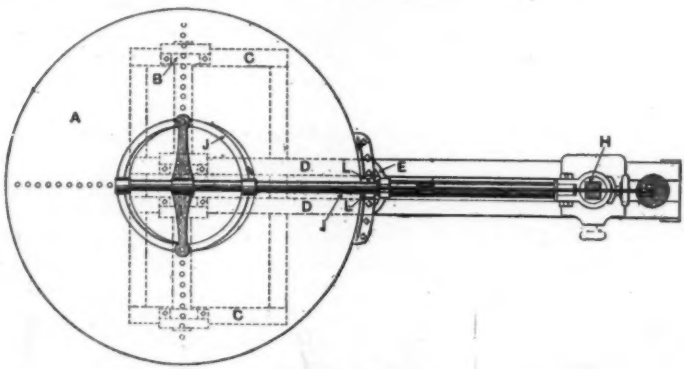


FIG. 4.—PLAN.

THE STUART MOULDING MACHINE FOR SPECIAL PIPE CASTINGS.

Cammell, Laird, & Co., Ltd., of the Cyclops Steel and Iron Works, Sheffield, have concluded the arrangement by which Messrs. Hunt & Sacre, of 1, Victoria Street, Westminster, S.W., acted as their London representatives, and have taken their own offices at No. 9, Victoria Street.

PIG-IRON SPECIFICATIONS OF THE BRITISH THOMSON-HOUSTON COMPANY.

THE above company are making a start in purchase of pig-iron by analysis instead of by fracture, and are issuing the following specifications to the trade:—

SPECIFICATION FOR SCOTCH FOUNDRY PIG-IRON.

No. 1 Foundry.

Described as "soft and rich."

Combined carbon ...	not over 0·2 per cent.
Silicon	„ 2·8
Sulphur	„ 0·05
Phosphorus	„ 0·90
Manganese	„ 2·0 nor under 1·0 per cent.

Remarks.—The sulphur, manganese, and phosphorus are most important, especially the manganese and phosphorus. The silicon must not fall below 2·8 per cent., but may rise to 3·5 per cent. Manganese must not fall below 1·0 per cent. The basis for sulphur is 0·01 per cent., and phosphorus 0·2 per cent.

No. 3 Close Foundry.

Described as a "close, hard, and strong No. 3."

Combined carbon	about 0·3 per cent.
Silicon...	not over 1·75
Sulphur	„ 0·05
Phosphorus ...	„ 0·90
Manganese... ...	„ 2·0 nor under 1·0

Remarks.—Silicon, phosphorus, and manganese are the most important items. Basis same as above.

SPECIFICATION FOR HEMATITE PIG-IRONS.

These are sub-divided into groups A and B. Group A is low in manganese and must be from British ores. Group B is higher in manganese and may be from mixed ores.

Group A, No. 1 Foundry.

Described as "soft."

Combined carbon ...	not over 0·3 per cent.
Silicon	2·5 to 3·0
Sulphur	not over 0·05
Phosphorus	„ 0·05
Manganese	„ 0·25

Group B, No 1 Foundry.

Described as "soft."

	Per cent.
Combined carbon ...	not over 0·4
Silicon	2·8 to 3·5
Sulphur	not over 0·05
Phosphorus	„ 0·04
Manganese ...	not under 0·75 nor over 2·0 per cent.

Remarks—The most important items are the sulphur, phosphorus, and manganese. The silicon is important also, but as we allow a wide margin it must not fall below the minimum given. Our chief use of hematite demands that the phosphorus and sulphur shall not exceed the given amounts, and the margin is so large that no iron exceeding it will be accepted. The basis for sulphur and phosphorus is 0·01 per cent.; for silicon 0·2 per cent.; for manganese 0·25 per cent.

Group B, No. 3 Foundry.

Described as "close grain, high in manganese."

	Per cent.
Silicon	not under 2·0 nor over 2·5 per cent.
Sulphur	not over 0·05
Phosphorus ...	„ 0·05
Manganese ...	„ 2·0 nor under 0·75 per cent.

Remarks.—All the items are of importance, but we do not specify the combined carbon. Sulphur, phosphorus, and manganese are the most important.

SPECIFICATION FOR SPECIAL PIG-IRONS.

These pig-irons can be divided for our foundry purposes into two classes—

(A) Medium pure iron high in manganese.

(B) Very pure iron low in manganese.

(A) *Cold blast, medium pure, high manganese iron.* Described as "grey or mottled."

	Per cent.
Total carbon ...	not over 3·0
Silicon	„ 1·0 nor under 0·5 per cent.
Phosphorus ...	„ 0·5
Sulphur	„ 0·05
Manganese ...	„ 2·0 nor under 1·0 per cent.

Remarks.—The phosphorus may be below 0·5 per cent. We do not state a minimum, but shall be strict as regards the maximum, which must not be exceeded.

(B) *Cold blast, pure, low manganese iron,* Described as "all grey."

	Per cent.
Total carbon...	not over 3·0
Silicon	„ 1·0 nor under 0·5 per cent.
Phosphorus	„ 0·05
Sulphur...	„ 0·05
Manganese	„ 0·75

Remarks.—Silicon, sulphur, and phosphorus are most important.

SPECIFICATION FOR PURE WHITE IRON.

Described as "all white, cold blast iron."

	Per cent.
Total carbon (this is to be all *combined carbon* and should not exceed)	3·0
Silicon	not over 0·5
Phosphorus	„ 0·08
Sulphur...	„ 0·10
Manganese	„ 0·75

Remarks.—No allowance will be made on the sulphur and phosphorus; they must not exceed the amounts given.

SPECIFICATION FOR ENGLISH FOUNDRY PIG-IRONS.

No. 1 *Foundry.*

Commonly described as an "extra soft very open grain, silicious grey iron."

	Per cent.
Combined carbon	0·01 to 0·15
Silicon	3·25 to 3·5
Sulphur	not over 0·05
Phosphorus	„ 1·50
Manganese...	„ 0·50

Graphite carbon may vary, but not to exceed 3·5 per cent.

Remarks.—The combined carbon, silicon, and sulphur are the most important items to us, *especially the combined carbon.* No allowance over the maximum for combined carbon can be made, nor below the minimum for silicon.

No. 2 *Foundry.*

Commonly described as "open grain, soft and grey."

	Per cent.
Combined carbon ...	...0·15 to 0·2
Silicon	...3·00 to 3·25
Sulphur	...not over 0·06
Phosphorus	„ 1·50
Manganese	„ 0·50

Remarks—See above.

No. 3 *Foundry.*

Commonly described as "soft grey."

	Per cent.
Combined carbon ...	0·20 to 0.40
Silicon...	2·75 to 3·00
Sulphur	not over 0·06
Phosphorus	„ 1·50
Manganese	„ 0·50

Remarks.—See above.

No. 4 *Foundry.*

Commonly described as "close grain, strong, and all grey."

	Per cent.
Combined carbon ...	0·40 to 0·50
Silicon...	1·80 to 2·50
Sulphur	not over 0·10
Phosphorus	„ 1·50
Manganese	„ 0·75

Remarks.—The most important items are the silicon, sulphur, and phosphorus. The combined carbon must not be below 0·40 per cent., otherwise the grain will not be close enough for our purposes.

STEEL CASTINGS IN BRITISH WORKS.

THE manufacture of steel foundry castings has of late years made very notable progress in this country. Twenty years ago, this industry was a very small one. In some districts it is still in considerable. But in Sheffield and in one or two other centres it is rapidly assuming large dimensions, and it is not improbable that the near future will have a different record of production.

There are not a few who regard the days of forgings as practically numbered. Their place is being taken by castings, which are both more economically produced and less liable to accidents and serious flaws. Most of the leading forges are now equipped with plants for the manufacture of steel castings, and others are contemplating taking up that branch of the foundry business.

LOSS OF IRON IN MALLEABLE FOUNDRIES.

In an interesting paper read by Mr. R. F. Flinterman, before the American Foundrymen's Association, the results are given of a number of test heats lately made to determine the amount of loss and shrinkage in malleable work. The melting was done in ordinary air furnaces.

In the annexed table it is shown in detail how the various heats were made up and also the total amount of iron recovered, both as castings and as scrap (sprue, floor riddlings, mill riddlings, etc.). The difference between total iron recovered and heat as made up gives the loss or shrinkage, this loss running from 3·36 per cent. to 8·03 per cent.

It was further attempted to ascertain as nearly as possible to what cause the loss and shrinkage might be due. We do not give in detail the methods employed for determining the character of the loss due to the chemical changes of various kinds, but these comprised chemical examinations of the iron ore sand. The loss due to chemical change, as given below, is due to the loss of carbon silicon and manganese. The causes of the loss were as under:—

—	Heats.				Average.
	No. 1	No. 2	No. 3	No. 4	
	%	%	%	%	%
Loss due to chemical change	1·17	1·01	1·05	·72	·98
Loss due to iron not recoverable	·90	2·10	2·10	2·40	1·87
Loss due to sand loss.	1·90	1·90	2·20	2·20	2·05
Total loss	3·97	5·01	5·35	5·32	4·90
Total loss as shown by table below	4·27	3·36	8·03	4·12	4·94

These figures go to show that 5 per cent. loss should be about maximum loss.

While there is more or less lack of correspondence in the results as obtained, they are nevertheless near enough alike to show that a loss of 8·03 per cent., as shown on No. 3 test, is probably due to an error in making the test.

—	Heat No. 1.		Heat No. 2.		Total 1 & 2.	Heat No. 3.		Heat No. 4.		Total of 3 and 4.	
	Pounds.	Per cent. of Melt.	Pounds.	Per cent. of Melt.	Pounds.	Pounds.	Per cent. of Melt.	Pounds.	Per cent. of Melt.	Pounds.	Per cent. of Melt.
Pig-iron	14,720	—	9,755	—	24,475	12,000	50·00	12,000	49·96	24,000	49·98
Sprue	15,200	—	10,520	—	25,720	12,000	50·04	12,020	50·04	24,020	50·02
Total iron melted	29,920	—	20,275	—	50,195	24,000	100·00	24,020	100·00	48,020	100·00
Product.											
Iron from milling slag	159	00·53	327	01·61	486	234	00·97	266	01·11	500	01·03
Scabs from furnace spouts	145	00·49	210	01·04	355	155	00·65	250	01·04	405	00·85
Mill riddlings ...	—	—	—	—	—	28	00·12	29	00·12	57	00·12
Sprue (including floor riddlings) ..	12,035	40·22	7,927	39·10	19,962	8,983	37·43	8,954	37·27	17,937	37·35
Total scrap ...	12,339	41·24	8,464	41·75	20,803	9,400	39·17	9,499	39·54	18,899	39·35
Castings (good and bad)	16,304	54·49	11,130	54·89	27,434	12,673	52·80	13.532	56 34	26,205	54·57
Total product ...	28,643	95·73	19,594	96·64	48,237	22,078	91·97	23,031	95·88	45,104	93·92
Loss or shrinkage	1,277	04·27	681	03·36	1,958	1,927	08·03	989	04·12	2,916	06·08
Slag from skimming heats ...	1,249	04·17	1,545	07·62	2,794	1,618	06·74	1,817	07·56	3,435	07·15
Iron recovered from slag ...	159	12·	327	21·17	486	—	—	—	—	—	—

AMONG THE FOUNDRIES.

The business of Messrs. W. Richards & Sons, of the Dinsdale Moor Iron Works, Fighting Cocks, Darlington, and the Britannia Foundry, Middlesbrough, has for family reasons been converted into a limited company, bearing the name of W. Richards & Sons, Ltd.

The Engineering Standards Committee have recently issued interim reports relating to the British standard specification for tubular tramway poles.

Mr. G. J. West has been appointed the Scottish representative for Messrs. Wailes, Dove, & Co. Mr. West has been representing Mr. W. A. Kinghorn, of Glasgow (agent for Clarke, Chapman, & Co., and Darlington Forge Company), for a number of years.

The business of the Preston Engineering Company, of Alexandra Works, Gillett Street, Ribbleton Lane, Preston, has been acquired by Messrs. W. Jackson & Son.

Hayward, Tyler, & Co., Ltd., hydraulic engineers, have removed from 90-92, Upper Whitecross Street, London, E.C., to 99, Queen Victoria Street, E.C.

The gross value of the estate of the late Mr. T. Towns, of Newcastle-on-Tyne, manager of Elswick Steel Works, is £4,627 17*s.* 6*d.*, including net personalty of £1,472 12*s.* 6*d.*

W. F. Mason, Ltd., engineers, of Manchester, have now taken possession of their new Alma Works, Levenshulme.

Messrs. Ashmore, Benson, Pease, & Co., of Stockton-on-Tees, have secured orders for a cast-iron tower scrubber for Clonmel and a steel tank and gas-holder for Gorey (Ireland); and the firm are also supplying a large tank and gasholder for the Cargo Fleet Iron Company's new works at Middlesbrough.

The Anderson Foundry Company, Ltd., lately received an order for the supply of fencing materials (consisting of cast-iron bases, wrought-iron posts, cast-iron pillars, and steel wedges) to the Burma Railways.

Templer & Ranoe, Ltd., engineers, have removed from Sterling Works, Spon Street, Coventry, to larger works in Foleshill Road.

The Wauntreoda Engineering Works and Foundry, Whitchurch, near Cardiff, belonging to Howard, Kyte, & Co., Ltd., were offered for sale by public auction on September 22nd.

Follows & Bate, Ltd., engineers, of Gorton, Manchester, have appointed Mr. J. E. Medcalfe, of 26 to 28, Audrey House, Ely Place, E.C., as their representative for London and district.

The change from steam to electricity as a motive power in the Park Works, Gateshead, of John Abbott & Co., Ltd., is making satisfactory progress.

The United Engineering Company, Ltd., 28, Budge Row, Cannon Street, London, E.C., have removed their offices to 4, Cullum Street, Fenchurch Street, E.C.

Messrs. Beyer, Peacock, & Co. have secured the order for thirty-one heavy express locomotives, to be made at their Gorton Works, for the East Indian State Railways; also for six twelve-wheeled locomotives for the Buenos Ayres Western Railroad. This is all the more satisfactory as it is in the face of keen American competition.

Messrs. Fleming & Ferguson, shipbuilders and engineers, of Paisley, have opened offices at 9, Fenchurch Avenue, London, E.C., and have appointed Mr. G. Anderson as their representative.

Mr. J. C. Davies, the general works manager of the Brunswick and Monway Iron and Steel Works, of the Patent Shaft and Axle Tree Company, Wednesbury, has been appointed general manager of the Swansea Hematite Iron and Steel Works, Elba Steel Works, Gowerton.

The late Mr. A. R. Hill, of the firm of Hill Brothers, Nevin's Foundry, Leeds, left estate of the gross value of £22,740.

MIDLAND NOTES.

(By Our Own Correspondent).

There is a slight improvement in the heavier trades of the Midlands, but manufacturers of household ironmongery are very slack with orders, while those chiefly concerned with the building trades are doing little or nothing. The tendency of the prices of pig iron to lift has given a spurt, but orders received are of the hand to mouth description, buyers being very careful in the matter of stocks.

Since the last issue of the Journal an important consignment of mining machinery has been despatched to South Africa, to the order of the De Beers Mining Company, Kimberley. The order was given some four months ago to Messrs. Heenan & Froude, ironfounders, &c., Worcester, and the firm are to be congratulated upon their quick delivery, there being about 600 tons weight of iron. The *employés* worked night and day in order to come within time limit, and it is very satisfactory to learn that they successfully accomplished their purpose.

The Griffin Foundry Company called a special meeting of its shareholders at the Midland Hotel, Birmingham, for the purpose of considering a proposal of the directors, to divide the business into two separate companies, viz. the showroom and merchants' department at Stephenson Place, and the foundry and heating department at Browning Street, Ladywood, both in the city of Birmingham. After some discussion resolutions were passed accepting the proposals. A new company has been formed and registered under the title of the New Griffin Foundry, with a capital of £20,000 in £1 shares, to acquire and carry on the showroom or factors' branch of the business of ironfounders previously carried on at Stephenson Street, Birmingham, by the Griffin Foundry Company Ltd. Also a new company called the Griffin Ironworks Company has been registered with a capital of £15,000 in £1 shares, to acquire the manufacturing branch of the Griffin Foundry Company Ltd., at Browning Street, Birmingham. The subscribers to this latter company are Messrs. A. Ewen, F. Moore, J. Styles, A. T. Payne, G. J. Withington H. G. Silk, and B. A. Krinks.

It is of the utmost importance that anything appertaining to the metal trades should be encouraged in every way possible, and that careful researches for the better development of metallurgical products should be constantly made. Foreign nations undoubtedly have been to the fore in demonstrating to their students the whys and wherefores of the chemical changes of the various ores, &c., that have to be used in the production of iron and steel, and it is with great satisfaction and pleasure that we notice that Birmingham, practically the heart of the iron and kindred trades, has decided to have attached to its university a metallurgical section. A few days ago, an inspection and lighting of the smelting furnaces, which have entailed an expenditure of £10,000, erected at Bournbrook, was made by students and friends. Professor Thomas Turner, during the proceedings, made a very interesting speech, stating that the commencement of laboratory work at Bournbrook marked an important event in the history of the metallurgical department. The erection of the buildings had occupied a year. There was no more ready index of the progress of civilisation in any nation than that afforded by the knowledge of the worth and value of its metallurgical products; and it was of the utmost importance that our metallurgical industries should be encouraged if Great Britain were to keep her position amongst the nations of the world. A great change had been witnessed during the last quarter of a century. England used to be spoken of as the chief coal and iron producer of the world, and occupied a

prominent position as a producer of other metals. We still led in gold, because of the Transvaal and Australia, bnt we were now second in coal, third in iron, fifth or sixth in other metals, and we only produced about one-twentieth part of the tin, lead, and zinc which was made in the world. He went on to enumerate the schools of metallurgy in America and Germany, and to show that some of them were on a scale that had hitherto not been matched in our own country, while their teaching had varied considerably from that which we had adopted. Granted that metallurgy was to form an integral part of university study, the question arose on what lines should the teaching proceed, and what equipment should be provided. Two styles of training had been recommended—that adopted by Dr, Percy at the Royal School of Mining, and the one in vogue at the newer schools of mines and metallurgy in America. Out of these there arose what he regarded as the system which they had endeavoured to initiate at Bournbrook. The older schools of metallurgy were either too exclusively theoretical or too exclusively practical. Those present had a tour round the department, the arrangements being of a very satisfactory kind. Everyone was delighted with the evident thought and care that had been given in the planning out of the scheme, which in a few years should result in a marked degree in improvements in the manufacture, and the use of iron in particular, and other metals in general.

Messrs. Thomas Holcroft, Ettingshall Foundry, Wolverhampton, since the outbreak of fire that took place upon their works several weeks back with lamentable results, have been extraordinarily careful, and have gone to much trouble in minimising the risk of a further conflagration. Just now the firm are erecting some additional buildings which will be practically fireproof.

Mr. Henry Davenport, who for many years acted as general engineer to Messrs. John Harper & Co., Limited, Albion Works, Willenhall, has resigned his position. During his stay with Messrs. Harper, Mr. Davenport introduced many improvements in the smelting of iron and annealing of castings.

SCOTTISH NOTES.

(By Our Own Correspondent.)

NO improvement can yet be reported in the Scottish ironfoundry trade. The prolonged depression in the shipbuilding and engineering trades has led to a decided scarcity of orders for heavy castings, and firms in Glasgow, Coatbridge, Motherwell, and Airdrie are all feeling the pinch of the continued dulness.

As to the light-castings trade, it was hoped that at the beginning of September there would be a marked and general improvement in that branch of the business, owing principally to the closing of the holiday season, when the heads of the leading buying houses would be back to work. There has, however, been no improvement in the trade. The state of matters in the Falkirk district may be taken as an index of what is to be found elsewhere. Out of thirty-two foundries in the Falkirk district, only seventeen are working full time. The others are working four and five days per week. A good many men in all branches of foundry work are unable to get employment. The chief cause of the continued dulness in the light-castings trade is the depression in the building industry throughout the country, and the scarcity of orders coming from the Colonies.

Mr. Simon Heeps, Irish traveller for the Carron Iron Company, whose headquarters have been the company's Glasgow warehouse, was met there on the evening of the 9th September by a

number of his fellow employees and friends and presented with a handsome dressing-case, a case of pipes, and a silver match-box, on the occasion of his leaving Glasgow to fill the position of chief agent at a new showroom which the Carron Company have opened in Dublin. Mr. Herbert Le Quesne, the company's Glasgow agent, made the presentation, and Mr. Heeps suitably replied.

The holiday question is perplexing a great many iron workers in the Falkirk district. The trades holidays in that district have for years past occurred between the end of June and beginning of July, but the gas-stove and gas-fire manufacturers are desirous of breaking through this arrangement and having the holidays fixed for August. This summer one of the firms arranged with its employés for having this change made. Another firm tried to do so, but were unsuccessful, and they have now posted up a notice to their workmen at their works that next year the holidays will be in August. The men think this is tantamount to "taking the bull by the horns," and there are already indications that the men will resist the alteration. Their chief reason for this is that while they will be working in June and July, the other foundry workmen in the district, amounting to eighty per cent., will be on holiday, getting the advantage of the cheap railway fares, which they will not have in August. Another reason is that the present arrangement as to holidays makes the better division of the year. Holidays in August will mean that they will have only four months, when they will have to go on holiday again at the New Year, and that prior to that they will have several days' holidays on the occasion of the September cattle trysts for which Falkirk is famed. The contention of the masters engaged in the gas-stove trade is that they suffer a loss through letting their works go on holiday in June and July, which is the busy season in their line.

A new foundry, which is to be devoted to the manufacture of light castings, is to be started in Airdrie, where there are at present a number of fairly prosperous foundries. I hear that a Falkirk gentleman is associated with the new enterprise.

The new foundry which is being erected at Bonnybridge for a firm of which Mr. Lane, formerly of Smith & Wellstood, Ltd., is the head, is being rapidly pushed forward. The works have now taken shape, and they are on fairly large scale. The first cast is ikel to take place some time next month.

The September report of the Associated Ironmoulders of Scotland states that the membership is 7,279, compared with 7,259 in December of last year. There are 574 workers on the idle list, compared with 629 last month. The report says: "We hope that many more of our unemployed brethren will drop into work ere the dark days once more overtake us, when the conditions of employment are not so favourable as in the summer or autumn day." The Greenock and Edinburgh districts show signs of improvement, but trade is reported not to be so good in Dundee, Aberdeen, and Coatbridge. The income of the Society for the month was £1,668 1*s.* 9½*d.*, while the outlay was £2,296 17*s.* 2½*d.*, showing a loss of £628 15*s.* 9*d.* on the month's working. The loss is chiefly due to the large sum paid for idle benefit.

At the Atlas Ironwoks, Gloucester, belonging to Messrs. Fielding and Platt, a fire has done considerable damage. These works are now devoting attention to the manufacture of suction gas producers.

Mr. W. R. Bogle, of Saltcoats, Scotland, has been appointed the Scottish representative for the sale of the steel castings manufactured by the Kohlswa Jernverks Aktiebolag, Kohlswa, Sweden.

QUERIES.

This department of the JOURNAL *undertakes the answering of queries in the following branches:* Blast Furnace Practice, Basic (steel making) Processes, Cast-iron, Malleable Cast-iron, Steel, Brass, Bronze, &c., *by eminent authorities in each branch. When necessary, the aid of chemical analyses, mechanical testings, micrographic, or microscopic examinations will be invoked.*

The queries will appear repeatedly till answered. No charge is made to readers for answers, except where chemical, mechanical, or micrographic analyses are necessary, in which case the actual fee paid by us will be charged.

There are many other queries outside the scope above referred to which reach us at various times which we trust our readers will afford us assistance in answering.

Communications should be addressed to the "Editor, THE FOUNDRY TRADE JOURNAL, 104, Great Russell Street, London, W.C.," *and marked outside* "QUERIES," *and must be accompanied by the correct name and address of the querist, not for publication, but as a guarantee of good faith, which will be treated, with strict confidence.*

Defective Castings.—Could you kindly tell me a good flux for molten iron? I have just cast a steam cylinder on its side. I used good scrap, a little Swedish pig, and remainder Carron pig. The metal was nice and hot, and when the casting was trimmed off it was perfect from a moulder's point of view; but when tested it leaked, so I broke it up, and I find at the end nearest to the runner a mass of dross as big as the palm of my hand. The casting was fed down the riser over where this dirty place is. Could you please explain the cause?

CYLINDER.

Annealing Castings.—I am engaged in the annealing of malleable and small steel castings. Our method is to pack them in iron pans with red ore. The castings are well annealed, but the ore gets burnt on or stuck to them, and is not only bad to get off, but it greatly spoils the appearance of the castings. Can you suggest any means of preventing this, and causing the ore to leave the castings readily, thereby giving them a nice, clean appearance?

MALLEABLE.

Cupola Linings.—We should feel obliged if you would kindly say through your paper what kind of bricks are the best for lining a foundry cupola, and where they are made; or possibly some of your readers might answer it.

MANHOLE COVER.

Bricks.—What kind of bricks are the best for lining a foundry cupola and where made?

YORKSHIRE SUBSCRIBER.

Loam.—I should be much obliged if any of your numerous readers will kindly give their experience, as to the average quantity of loam required for use in an iron foundry turning out about 140 to 150 tons of fairly light castings per week. It would be interesting to know the average quantity of loam bought for each ton of iron casting.

NORTHERN SUBSCRIBER.

Plates for Enamelling.—I wish one of your numerous readers would please explain an item of interest to me. We are at present making a great many plates for enamelling, we do not see any fault with the plates as they pass through the examining shop, and we look at them very carefully, nevertheless we have a good few come back from the enamelling shop with small holes in them about $\frac{1}{16}$ in. deep, and about the size of a small pin's head. Would some one please inform me the reason that the enamel will not fill up these small holes, or how we can stop them as moulders? One anxious to learn.

BLACK SAND.

METAL MARKET REPORT.

London, September 15th.

TIN.—Considerable interest has centred in this metal, and the demand has been fairly brisk. The premium on speculative purchases for future delivery has stiffened, and prices which were £125 15*s.* on the 8th inst., are at the moment of writing £126 7*s.* 6*d.*

Copper.—There is little to record that is fresh, but the market is slightly more stagnant. On September 8th, quotations were £57 6*s.* 3*d.*; on September 15th, £57 8*s.* 9*d.*

Spelter.—The market is slow and rather weaker. Good ordinary brands are £22 11*s.* 3*d.* to £22 12*s.* 6*d.*

Lead.—Recent reductions in warehouse stocks have stiffened the market to £11 17*s.* 6*d.* for soft Foreign and half-a-crown more for English.

Pig-Iron.—Pig-iron has experienced something of a set-back during the past week, and, indeed, the general condition of business at the present time is far from encouraging. The improvement which took place last week has proved to be of an ephemeral character. In the Cleveland district the less satisfactory tone of the market has been brought about to some extent, no doubt, by the restriction of the export to the Continent, where the drought still interferes with inland navigation. Buyers there, being unable to get British iron in any large quantities up the canals, are naturally buying more of the native qualities. In the hematite trade there is no improvement to report. Prices are declining, while the cost of production remains stationary. As a result, profits are being gradually reduced. At the present time mixed numbers on the East Coast are not realising more than 49*s.* 6*d.* per ton, and steel trade prospects are not sufficiently good to render any early recovery probable.

PUBLIC STORES STOCKS OF PIG-IRON IN TONS AT LATEST DATE AVAILABLE:

	Sept. 15 1904.	Sept. 17 1903.	Decrease.
Connal's at Glasgow	9,554	12,600	3,046
Connal's at Middlesbrough ...	80,630	133,800	53,170
Connal's at Middlesbrough hematite ...	300	300	...
West Coast hematite	13,280	16,760	2,880
Totals ...	103,764	162,860	Net dec. 59,096

* * *

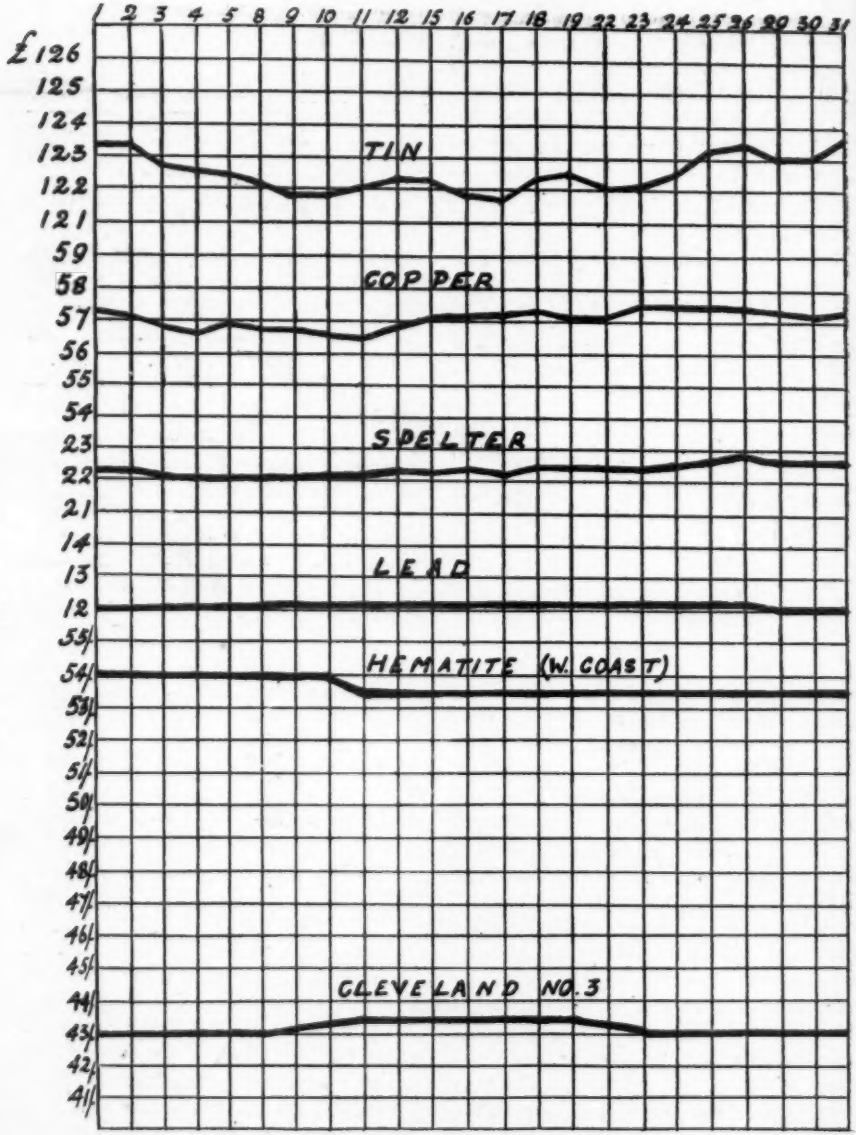
PRICES OF METALS.

APPROXIMATE prices and position at latest date for which statistics are available, with prices and quantities at the corresponding dates in each of the last two years:—

METALS.	1904.	1903.	1902.
Iron—Scotch pig warrant ton	.....51/9 nom.	.....50/6	..... 57/10
—Middlesbro' warrants ton	..... 43/2½	..... 45/2½	.....53/6
—W.C. M/nos Bessemer ton	..... 53/6	.....57/3	.....61/0
—Staffordshire bars, Lond. ... ton	£6 10—£8 10	.....£7—£7 5	.....£7—£7 5
—Welsh bars, Wales... ton	... £6—£6 5	.. £6—£6 5	.....£6—£6 5
—Stock, Scotch, Sep. 16 tons	 9,554	12,308	41,131
Copper—Chili bars, GMB ton	£57 7/6-57 8/9	56 15—56 17/6	52 17/6-52 18/9
—Stock, Europe and afloat... tons	12,882	15,712	20,275
Tin—English ingots ... ton	£127 10-£128	£122 10-£123	£122—122 10
—Straits ton	126 7/>1268/0	120 15-120 17/0	£121 15—122
—Stock, Ldn, Hind. and afloat... tons	 9,079	13,489	10,316
Tinplates—Charcoal I.C..... box	.....12/9—14/3	.....13/0—15/0	.....14/0—15/6
Lead—English pig ton	£12—£12 2/6	11 10—11 12/6	11 2/6—11 5
Spelter—Ord. Silesian ton	22 11/3-22 12/6	...£21—21 2/6	19 5/0—19 7/6
Quicksilver—(75lb.) bottle	..... £7 15	..... £8 7/6	..... £8 15
Antimony—Regulus ton	£26/10-£27	... £26—£27	... £29—£30

The firm of Messrs. Arthur G. Enock & Co., refrigerating engineers, has been converted into a limited liability concern, and will, in future, trade under the style of Arthur G. Enock & Co., Ltd. Mr. A. G. Enock, who established the original company, holds 50 per cent. of the shares, and is retained as managing director.

CHART OF THE FLUCTUATIONS OF THE METAL MARKET IN AUGUST.



NEW INVENTIONS.

List specially compiled for THE FOUNDRY TRADE JOURNAL by MR. GEORGE BARKER, Fellow of the Chartered Institute of Patent Agents, Consulting Engineer and Expert, 77, Colmore Row, BIRMINGHAM.

Telephone No. 1,300. Telegraphic Address—"PATENT, BIRMINGHAM."

No. 16,250/1903. THE SANDYCROFT FOUNDRY COMPANY, LTD., and P. C. KELLY.

The shafts or stems of "Ore Stamp Mills" are by this invention provided with a tappet which is readily removed therefrom without interfering with any portion of the mill.

FIG. 1.

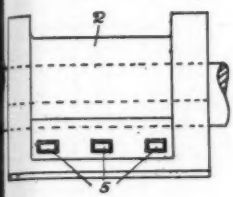


FIG. 2.

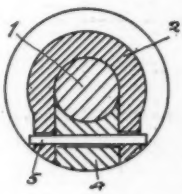


FIG. 3

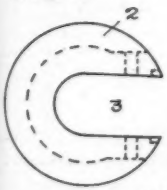
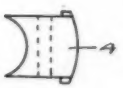


FIG. 4



PATENT No. 16,250/1903.

The tappets, which are usually in the form of a cylindrical sleeve, are formed in two sections; one, the larger, being formed with a longitudinal gap, at least equal to the diameter of the stem or shaft to which it is to be applied; the smaller section is formed to fit in and fill the gap in the larger section, the parts being drawn together by cotters or pins.

The drawing, Fig. 1, is an elevation of a tappet as applied to the stem of a stamp mill.

Fig. 2 is a sectional plan of same, and Figs. 3 and 4 are respectively plans of the larger and smaller sections detached.

1 represents the stem or shaft; 2, the larger section provided with the gap 3, into which the smaller section 4 is adapted to fit, being held therein and to the stem by cotters or pins, 5.

No. 20,480/1902. N. S. JENKINS, Dresden. Melting Apparatus.

This invention is for a melting apparatus for easily fusible metals, and though not of direct interest in foundries, might be of use in metallurgical laboratories. The apparatus consists of a muffle *a*, provided at the front with an opening to allow of the introduction of the ladle and for superintending the process of melting. The muffle is adjustably fixed to an upright *b*, and the bottom *c* thereof has an opening for the admission of heat, and is lined with a ring of asbestos *d*, as also are the sides *e*. The muffle is fitted with a removable cover *f*, which has an opening for increasing the draught and is lined with asbestos or other refractory material *g*. The ladle is supported in a socket *k* of a carrier or arm *i*, which is mounted on the burner *h*, being adapted to turn or swing thereon. A set screw *m* is arranged for fixing the arm at any desired point.

FIG 1

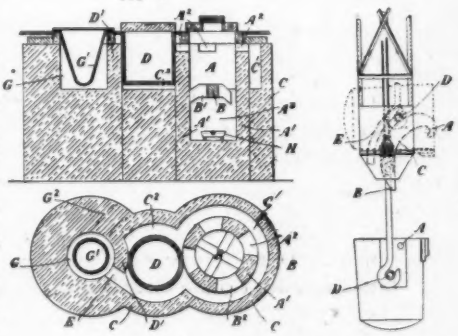


FIG 2

No. 22,484/1903. J. S. Cooper, Pittsburg. "Furnace Doors."

The object of the invention is to construct a furnace door in which air is freely admitted in such a manner as to preserve the door, and at the same time enable it to withstand a very great heat.

On the drawing, Fig. 1 is a front elevation showing the door applied to a furnace; Fig. 2 a perspective view of the door, with the firebrick removed; and Fig. 3 is a horizontal section of the door.

The door frame or casting comprises a front plate (1), side walls (2), and top wall (3), all of which are cast integral.

FIG 1

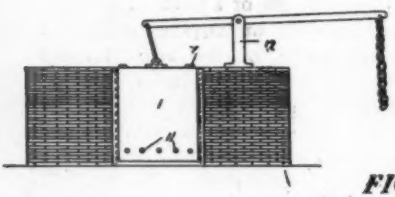


FIG 2

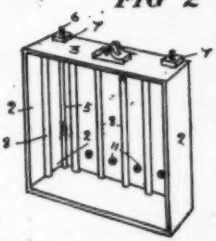


FIG 3

The bottom (4) is tied to the remainder of the frame by vertical bolts or tie rods (5), having their threaded ends (6) extending through the top walls (3), with nuts thereon for holding. The inner surface of the front wall is provided with vertical ribs (8), and a vertical rib is also placed on the inner face of each of the side walls. In the casing a plurality or layers of firebrick (9) are placed, the ribs (8) holding the same some distance away from the walls, so as to leave an air space (10) to which air is admitted through openings (11) in the front plate (1).

A lifting device may be provided, such as the one shown at (12).

The admission of cool air into the space (10) surrounding the refractory material keeps the door in a comparatively cool state, and prevents the warping of the metallic frame or casting.

BRITISH CONSUMPTION OF FOUNDRY IRON.

The total consumption of foundry iron in the United Kingdom has never been accurately ascertained. Details are given of the production of foundry and forge iron, but the two are lumped together, and it can only be assumed that the output of foundry iron is the total of this quantity left after the forge iron required for the purposes of the finished iron industry has been deducted. The output of finished iron in Great Britain in 1903 was rather over 900,000 tons, which would represent roughly fully a million tons of forge iron, and as the total make of both descriptions was 3,875,826 tons, it would appear that the output of foundry iron, as such, would be about 2,800,0.0 tons. Of this quantity, however, a certain proportion would be exported, and there is no record of what this figure may be. This uncertainty is a matter for regret, and should, if possible, be got rid of at the earliest opportunity. We doubt whether the total foundry consumption—apart from steel foundries—is equal to two million tons.

American Steel Foundries.—In 1901 there were fifty-six open-hearth steel plants which were prepared to make steel castings, and in June, 1904, there were eighty-four plants. The production of open-hearth steel castings has greatly increased recently.

The number of small Bessemer plants has also increased since 1901, all of which make steel castings. Steel castings are also made by twenty-six crucible plants; also by a few plants which use special processes.